# STUDY REPORT

## SR 253 (2011)

# Sustainability of the New Zealand Housing Stock

J. C. Burgess

Funded by BRANZ from the Building Research Levy

The work reported here was funded by BRANZ from the Building Research Levy.


ISSN: 1179-6197

## Preface

This report contains the results of a BRANZ study into the operational environmental sustainability of homes in New Zealand, being the environmental impact of the way that we operate and live in our homes.

The research leveraged from the levy project 'The Housing Stock Life Cycle and Sustainability', and identified the gap between the current state of the housing stock and where it needs to be to meet related NZ policy targets. This was done by cohorts using the Homestar™ tool, and provides a comparison with international home-building renovation practice (particularly the UK, Code for Sustainable homes). Interaction with New Zealand central government agencies enabled some policy analysis, as well as making comparisons with other environmental assessment tools including the Green Homes scheme, ANZHERS tools, and Beacon Pathway's High Standard of Sustainability.

The research will help to ensure that New Zealand homes are more sustainable and updates our information regarding the sustainability of our homes.


## Acknowledgments

The review, guidance on strategic direction, and input from Rebecca Mills of the Ministry of Green is gratefully acknowledged.

This work was funded by the Building Research Levy.


## Note

This report is intended for the use of policy analysts, technical analysts, and those involved with tools for measuring the sustainability or environmental impact of housing (particularly the Homestar tool).

# Sustainability of the New Zealand Housing Stock

## BRANZ Study Report SR 253


## J.C. Burgess


## Reference


Burgess, J. C., 2011. 'Sustainability of the New Zealand Housing Stock'. Study Report no. SR 253, BRANZ Ltd, Judgeford, New Zealand.


## Abstract


This report contains the results of a BRANZ study into the operational environmental sustainability of homes in New Zealand, being the environmental impact of the way that we operate and live in our homes.

The major finding is that: New Zealanders live in homes that have high environmental impact, with homes built in the last decade having half the environmental impact of homes constructed before this.

While there are international aspirational targets for homes to have zero environmental impact, New Zealand homes are far from this ideal, rating between two and four stars out of ten, using the Homestar™ rating tool.

The government has no mandatory policy for improving the operational environmental sustainability (Sustainability) of existing homes, however a subsidised voluntary programme run by the EECA ('Warm Up New Zealand: Heat Smart') is causing significant Sustainability uplift through improving the energy efficiency of the existing housing stock. This programme and other pathways for improving the operational environmental sustainability of the housing stock are available, and offer opportunities for government agencies to improve the Sustainability of the housing stock, although work is required to determine the best choice of instruments.

This report presents the issues pertinent to the Sustainability of the New Zealand housing stock, and introduces a metric to represent the Sustainability of this stock – Homestar™. The version of Homestar™ in this work uses 52 parameters to define measures of the energy, health, water use and management, indoor environment quality (IEQ), waste and site management of the housing stock – which is subtended into 15 typologies.

This report also surveys and summarises legislation applied by the New Zealand central government and its agencies that is relevant to the Sustainability of the housing stock. The government agencies charged with implementing this legislation have been identified, and their resultant policies and

aspirations relevant to Sustainability summarised. The potential impact of this policy and aspiration on the Sustainability of the 15 modal homes has been determined, and Homestar™ ratings generated as a result of applying the policy/aspiration for each agency and each typology. This has allowed an assessment of the impact of the agency policy/aspiration on the Sustainability of the New Zealand housing stock to be developed in terms of a Homestar™ rating. A comparison with Sustainability policy internationally has been made with a focus on the mandatory requirements of the Code for Sustainable Homes (CSH) in the UK.

The results show that:

- The typical Sustainability of the New Zealand housing stock is low.
- The typical Sustainability of the New Zealand housing stock is compliant with the requirements of the New Zealand Building Code (NZBC) applicable at the time of construction.
- Homes constructed in the last decade can be operated significantly more sustainably than homes from earlier periods.
- Improved energy efficiency has been the major cause of improved Sustainability in homes constructed in the last decade.
- The aspirational goals of the Energy Efficiency and Conservation Authority (EECA) for improving the energy efficiency of existing New Zealand homes could have more effect on the Sustainability of the existing New Zealand housing stock than legislation applied by any government agency for new or existing homes.
- Policy from government agencies (other than EECA) have no discernable effect on the Sustainability of the existing housing stock, although improvements in insulation requirements have been applied to new homes through the Department of Building and Housing (DBH).
- The combined policies and aspirations of government agencies could engender significant uplift in Sustainability if applied to the existing housing stock.
- The government has no plans to create uplift in the Sustainability of new homes, nor mandatory requirements for improving the Sustainability of existing homes, outside of voluntaryenergy efficiency goals.
- There are no mandatory government policies regarding energy, health and comfort, potable water consumption, organic waste management, indoor moisture management, site vegetative cover, and site location for existing homes

## Contents

## Figures Page



## Tables Page

# 1 DEFINITIONS AND ACRONYMS

| | |
|---|---|
| ANZHERS | Australia and New Zealand Home Energy Rating Scheme |
| Agency | Ministry, department, authority or agency of the central New Zealand government |
| DBH | Department of Building and Housing |
| DHW | Domestic Hot Water |
| DIA | Department of Internal Affairs |
| DOC | Department of Conservation |
| EECA | Energy Efficiency and Conservation Authority |
| EPA | Environmental Protection Authority |
| ETS | Emissions Trading Scheme |
| HCNZ | Housing Corporation of New Zealand |
| LCC | Life Cycle costing |
| LGA | Local Government Act |
| MAF | Ministry of Agriculture and Forestry |
| MCDEM | Ministry of Civil Defence and Emergency Management |
| MED | Ministry of Economic development |
| MEPS | Minimum Energy Performance Standards |
| MfE | Ministry for the Environment |
| NES | National Environmental Standards |
| NIWA | National Institute of Water and Atmosphere |
| NPS | National Policy Statements |
| NZEECS | New Zealand Energy Efficiency and Conservation Strategy |
| NZES | New Zealand Energy Strategy |
| NZBC | New Zealand Building Code |
| NZWS | New Zealand Waste Strategy |
| PV | Photo Voltaic array |
| RMA | Resource Management Act |
| Sustainability | Operational environmental sustainability, being a measure of the environmental effect of operating a home, which includes the energy, water, waste and materials used in occupying and keeping the internal conditions of a home appropriate for human habitation (but not including maintenance) |
| TA | Territorial Authority |
| WMA | Waste Minimisation Act |

# 2 INTRODUCTION

The operational environmental sustainability (Sustainability) of the New Zealand housing stock is vital to all New Zealanders since we all live in homes. The policy that is held and implemented by the New Zealand government regarding the Sustainability of our homes is therefore also vital, since this is a means through which change can be mandated. Further reasons for its significance include:

- Sustainability is important to the central New Zealand government, since homes are where our people are domiciled, and therefore the physical conditions in the home plays a significant part in the ability of the population to engage in productive activity
- Sustainability is important since the environment is a limited resource that cannot be exploited without ramifications – which are becoming clearer as the effect of climate change impinges on our homes and lifestyles
- Sustainability is important because our use of the environment places ongoing limits on our ability to live within it
- Sustainability is important since homes are responsible for a large part of the resource consumption and demand that must be supplied throughout New Zealand.

Knowledge of the Sustainability of the New Zealand housing stock is the first step in the path to achieving adequate levels of sustainability which will enable this stock to meet and continue to meet the demands of the country's population.

Understanding the policy that is being implemented by the New Zealand government is the second crucial step in ensuring that policy is serving the intended ends of improving Sustainability.

## 2.1 REPORT STRUCTURE

This report is designed to provide the main results of this investigation first before enlarging on the results, and presenting the detail of how these results were obtained. Consequently, Section 3.1 presents the main results about the operational sustainability of homes in New Zealand, with the enlargement and detail in Section 0. Likewise the main result from the investigation of government policy is presented in Section 4.1 and the detail of how these results were obtained in Section 4.2. Following this is the general discussion and conclusions.

# 3 THE OPERATIONAL ENVIRONMENTAL SUSTAINABILITY OF HOMES IN NEW ZEALAND

The main result of this section is:

- We live in un-sustainable homes.

Improving this situation means upgrading the sustainability of New Zealand homes, which is being partially achieved for existing homes through the EECA programs. Significant sustainability uplift could be achieved through addressing all aspects of the sustainability of existing homes, and changes to the Building Code to improve the new housing stock.

## 3.1 How unsustainable are our homes?

The New Zealand housing stock has a significant effect on the environment, with typical existing homes scoring only two out of a possible 10 stars for their operational environmental sustainability. Homes constructed after 2003 manage to score a four out of 10, but there are only 60,000 of these (out of 1.6 million homes), and only 150,000 people (out of four million) live in them.

It is important to understand just how unsustainable our homes are, so that we recognise the impact of our homes on the New Zealand environment. This allows us to take steps to improve the Sustainability of our homes, reduce the environmental impact of living in them, and the cost of meeting our international obligations regarding emission reduction.

Operating unsustainable homes means that our homes consume more energy and drinking-quality (potable) water, and produce larger quantities of waste and other pollutants than is necessary. The resource impacts are discussed below.

### 3.1.1 Energy

The total average energy consumption per New Zealand home is 11,410 kWh/year (Isaacs, 2003). The operation of New Zealand homes consumes 61 PJ, or 12% (MED, 2008), of New Zealand's purchased energy per year including 44 PJ, or 33% (EECA, 2010), of generated electricity. Living in our homes is responsible for 3.4 Mt (EECA, 2010), or 4%, of New Zealand's annual greenhouse gas (GHG) emissions. Internationally this is low since we do not use a large amount of energy to heat our homes, and our agricultural sector is responsible for around 50% of our GHGs (MED, 2008)

Energy is either reticulated or supplied in bulk (purchased energy such as electricity and bottled and piped gas and oil) or is generated on-site (renewables from solar, wind, water and solid fuels). The proportions of purchased energy and electricity vary. However it is possible to run a home without any purchased energy, which places a lower level of demand on national energy production and infrastructure.

#### 3.1.1.1 Space heating

Of the 11,410k Wh/yr average total energy use of a New Zealand home, a typical home uses around 4,000 kWh/yr (Lloyd, 2009) for space heating which sums to 23 PJ, or 5% (EECA, 2010), of New Zealand's purchased energy per year.

The amount of energy that is purchased to directly heat internal spaces is determined by the level of envelope insulation.[1] If a home is well insulated and makes use of passive design, it is possible to heat the internal spaces of a home with no purchased energy, and this reduces the GHG emissions associated with the supply of this amount of energy.

#### 3.1.1.2 Envelope insulation

Assessment of the envelope insulation is required, since it is a measure of the resistance to the flow of heat in $m^2K/W$ provided by an envelope surrounding the habitable space. This envelope is typically formed of the floors, external walls, glazing and ceilings adjacent to external spaces. The use of insulation in New Zealand homes was codified in April 1978 following the introduction of NZS4218P – the housing and small building energy efficiency standard (provisional). This standard now (2009 requirement) provides levels of insulation for floors (R 1.3), walls (R1.9/R2),[2] glazing and skylights (R0.26/R0.31) and roof/ceilings (R2.9/R3.3). Work performed by BRANZ (Isaacs, 2003) has identified that 900,000 homes have no (or inadequate) envelope insulation, which means that energy is wasted in space heating homes. This makes it difficult to maintain internal temperatures at acceptable levels.

#### 3.1.1.3 Water heating

Of the 11,410 kWh/yr, a typical home uses 3,300 kWh/yr (Isaacs, 2003) for water heating, which sums to 24 PJ, or 5% (MED, 2008), of New Zealand's purchased energy per year. This is the amount of energy that is purchased to directly heat water for sanitary purposes in internal spaces. This does not include the non-purchased heat that may be captured from a wetback or solar water heating system.

If hot water is conserved, solar or wetback water heating used, and storage tanks are insulated, it is possible to need no purchased energy for water heating. Again this reduces the operational costs of the home, the demand on the supply of energy required from homes, and the associated GHG emissions from the supply of this energy.

### 3.1.2 Potable water

The total average potable water consumption per home is 1,100 litres per day (L/day) (Statistics NZ, 2006). The operation of our homes consumes between 100 litres per person per day (L/p/d) as measured in the Waitakere NOW® Home (Easton, 2008), and 780 L/p/d supplied to the average resident of Queenstown (QLDC, 2007), with an average of around 400 L/p/d (GWRC, 2010).

1 This does not include the heat emitted from refrigeration, lighting and other systems, which have a different primary purpose but emit heat as a by-product of their primary operation. This also does not include the passive heating provided by solar gains, or by pets and occupants.

2 The first bracketed number is relevant to climate zones 1 and 2 from NZS4218 (the North Island, excluding the volcanic plateau), and the second number is relevant to climate zone 3 (the South Island and the volcanic plateau of the North Island).

This is the amount of drinking-quality water in L/p/d that is provided through a local authority and supplied to a home. The water may not be directly charged for (e.g. through water rates measured with a meter), but may be otherwise included in the rates bill from the local authority. This does not include water that is harvested from rain, or from local springs or streams. All the water supplied to our homes by council reticulation is of drinking quality, but only a small portion is used for human consumption.

Reducing our demand for potable water reduces the costs of infrastructure maintenance and development, and the demand for a resource which is finite.

### 3.1.3 Waste

A typical home produces 830 kg of waste per annum, being 40% of the 3.2 million tonnes of waste sent to landfills in 2006 (ARC, 2010). This comprises 2% of New Zealand's contribution to GHGs (MfE, 2010). Half of this domestic waste is organic waste that could be site-composted or used in worm farms (MfE, 2010).

This is the volume or weight of solid waste that is created through the occupation and use of homes, and typically comprises paper, plastics, glass, metals, organics (both soft kitchen food wastes, garden green wastes and harder garden wastes such as soil and rock), leather, rubber and clothing. It can include construction wastes and hazardous materials. Much material can be recycled, although is often contaminated or co-mingled which makes recycling more challenging.

Reducing our waste decreases the costs on municipal and national infrastructure, and reduces the GHGs emitted by the decomposition of organic wastes in landfills.

### 3.1.4 Materials

Although 'materials' is recognised as a contributor to a home's sustainability, it is largely through the choice of materials at construction, alterations and additions that this is relevant. This work is about the operation of the home, so does not assess material choices.

### 3.1.5 Home management

The manner in which a home is managed can have a significant effect on Sustainability. Socially-dependent choices such as drying clothes inside, not opening windows to vent moisture, use of unflued gas heating, or lack of maintenance on dripping taps or leaking water pipes can have a significant effect on the moisture loading of the home. This can contribute to our homes maintaining humidities that are outside of the recommended range for New Zealand homes given by Beacon (Easton, 2008)

### 3.1.6 Site issues

These include the site coverage with absorbent ground cover, landscaping, presence of pest plants, ability of the site to produce food crops from plants and trees, and the location of the home near transport routes and other services and facilities. These are all important metrics of Sustainability. There is also consideration of native planting to maintain local biodiversity, which will impact on the availability of native corridors.

## 3.2 Determinants of sustainability

The current New Zealand housing stock exists as a result of both explicit and implicit decisions that have been made in the past about provision for accommodation and urban form at all levels of government. It has been heavily shaped by the cultural background and aspirations of the housed population, as well as international expectations.

Until the oil shock of the 1970s little interest was shown in household energy use in New Zealand, as reflected in the first requirement for home insulation being legislated as a provisional requirement in 1978 (NZS 4218P 'House and small building energy efficiency' code). This code was not granted the status of a full standard until 1996 when an updated version was developed. In addition, no instruments to drive the performance of other Sustainability parameters (water, waste, IEQ etc) were available.

The poor level of Sustainability of New Zealand homes can be shown by applying the Homestar™ instrument to define the sustainability of our housing stock and comparing the results with other internationally recognised tools, such as the CSH used in the UK. The process is as follows:

- defining Sustainability parameters for homes and comparing to international tools (Section 3.2.1)
- Homestar™ as a metric of environmental sustainability (Section 3.2.6)
- dividing New Zealand homes into representative groups – typologies (Section 3.2.6.1)
- defining the Sustainability of a modal home from each typology (Section 3.2.7)
- rating results (Section 3.2.8)

### 3.2.1 Sustainability parameters for homes

The environmental sustainability of the operation of the New Zealand homes is about the impact on the environment that is made by the existence and use of the New Zealand housing stock. But what parameters are important in a Sustainability assessment?

While there is no universally accepted definition of operational environmental sustainability in the context of the operation of residential building, Sustainability must include all those aspects of a home that impact upon the environment. The following information presents the parameters that have been used internationally to represent home Sustainability, where the level, volume or amount of consumption or generation of the parameters are of importance.

### 3.2.2 US and Canada – LEED tool for homes

The LEED tool (USGBC, 2008) is used in the US and Canada as a means of assessing the sustainability of buildings, and has a variant for use in assessing homes. It deals with Sustainability parameters in different ways from the Homestar™ tool. The major parameters are dealt with under the headings Innovation and Design, Location and Linkages, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, IEQ, and Awareness and Education.

### 3.2.3 Australia – Greenstar, BASIX and NaBERS

Greenstar (GBCA, 2008) in Australia deals only with multi-residential systems, but includes building management, IEQ, energy, transport, water, materials, land use and ecology and GHG emissions.

BASIX (NSW Planning, 2010) is an acronym of the Building Sustainability Index that was developed for the Department of Planning of the New South Wales government in Australia. It addresses potable water, GHGs and thermal performance, and replaces the energy efficiency requirements of the Building Code of Australia for residential developments in New South Wales.

The NaBERS tool (NSW OEH, 2009) is a national Australian initiative managed by the Office of Environment and Heritage providing a performance-based rating system for existing buildings. NaBERS rates a building on the basis of its measured operational impacts on the environment, and provides a simple indication of how well environmental impacts are managed.

### 3.2.4 England, Wales and Northern Ireland – CSH

The Code for Sustainable Homes (CSH, 2010) in the UK covers Energy/$CO_2$, Water, Materials, Surface Water Run-off (flooding and flood prevention), Waste, Pollution, Health and Well-being, Management and Ecology. An overview of this tool is included in Section 4.3.1.

### 3.2.5 New Zealand – Greenstar, High Standard of Sustainability and Homestar

The BRANZ Green Homes tool (Jaques, 2004) was developed in the 1990s and included characterisation of thermal efficiency, appliance efficiency, sustainable materials, recyclable material storage, water economy, site selection, compost system, spatial efficiency, climate change readiness, moisture management, smoke detection, hazardous material storage, and design excellence. A variant on this tool – the 'Existing Homes tool' – is able to deal with: GHGs, sustainable materials, waste, water consumption, indoor environment, and indoor air quality. The 'Renovation tool' is able to deal with: household energy consumption, sustainable materials, waste, water consumption, safety, and climate change. These tools have been superseded by Homestar™, which includes consideration of energy, health and comfort, potable water, waste, home management and site issues.

Beacon Pathway utilise the 'High Standard of Sustainability' or HSS (Easton 2008) as a means to assess and characterise the Sustainability of homes in New Zealand. The HSS instrument nominates the same sustainability parameters as in the Green Homes tool.

While detailed comparative work is still being undertaken, new homes built to achieve the Beacon HSS appear to be roughly comparable with a "good" rating (56-69 points) under the BRANZ Green Homes Scheme, or a Level 4 compliance with the UK CSH. This compares, for example, with the average new New Zealand home, which would score around 15 points under the BRANZ Green Homes Scheme and not achieve a rating on the UK CSH.

### 3.2.6 Homestar™

The Homestar™ tool is used as the metric for sustainability in this work. It assesses the environmental sustainability of living in a New Zealand home, with the following parameters, as determined in the previous section:

- health and comfort
- use of drinking-quality water
- management of waste produced by living in the home

- management of the indoor environment
- site issues and location.

In Section 3.2.6.1, the common types of homes in New Zealand are defined and used to represent all the homes constructed in that era. These are referred to as typologies, with all the homes in each typology being a cohort. In Section 3.2.1, the choice of sustainability performance for a modal home in each typology is justified, and the results for the modal homes from each typology are presented. In Sections 3.2.2 to 3.2.5, these results are compared to the results from other international tools, with tools available in the UK, US, Canada and Australasia also discussed.

There are three versions of the Homestar™ tool available, with the detail discussed in the Appendix (Section 7.1). This work makes use of the self-assessment version of the Homestar™ tool. This version requires the answering of multi-choice questions to define home sustainability which are readily defined for a modal home of each typology. The 'points' that are awarded to each category are shown in Table 1.

| Homestar™ Categories | Points |
|---|---|
| | |
| Energy | 25% |
| Health and comfort | 23% |
| Water | 21% |
| Waste | 4.5% |
| Home management | 15.5% |
| Site | 11% |

**Table 1: Points awarded for categories of Homestar™ tool**

### 3.2.6.1 Typologies

The existing New Zealand housing stock comprises 1.61 million units, as reported in the census data of June 2009. However, construction methods have not been static during this time, and the types of buildings used as homes have changed significantly since the first permanent homes were constructed in New Zealand in the 19$^{th}$ century. There have also been significant changes to the NZBC which have served as demarcations between different types of New Zealand housing.

To adequately represent the New Zealand housing stock, it can be segregated into groups of homes (cohorts) built over a defined period with similar characteristics or similar NZBC requirements known as typologies. The most recognisable typology may be the Art Deco style, popular in New Zealand between 1925 and 1950, which pre-dates the typologies referred to as Villas which were constructed in New Zealand between the approximate years of 1890-1920, and Bungalows between 1920-1940. A set of typologies was introduced by Beacon (Ryan et al, 2008), and was extended for the purposes of the Homestar™ tool into 15 typologies, as shown in Table 2.

Note that the titles and time periods in this table are indicative. For example:

- the House 80s refers to a typology of housing that covers the period from 1979 to 1989

- the Late 90s cohort contains housing that was originally constructed between 1997 and 2003
- the Mid-2000s period pertains to the mid-point of the first decade of the 2000s, and
- the Late 2000s relates to the end of the first decade of the 2000s.

These typologies allow the attribution of common performance to a modal home for each cohort of homes so that the New Zealand housing stock can be characterised.

| Typology | Period |
|---|---|
| | |
| **Early housing** | Pre 1890 |
| **Villas** | 1890-1920 |
| **Bungalows** | 1920-1940 |
| **Art Deco** | 1925-1950 |
| **Detached State/mass** | 1930-1950 |
| **Detached State/mass** | 1950-1960 |
| **Detached State/mass** | 1960-1970 |
| **Multi-unit 60s-70s** | 1960-1970s |
| **House 1970-78** | 1970-1978 |
| **House 80s** | 1979-1989 |
| **House Early 90s** | 1990-1996 |
| **House Late 90s** | 1997-2003 |
| **House Mid-2000s** | 2004-2008 |
| **House Late 2000s** | 2009-2010 |

**Table 2: Typology separations and periods for cohorts of representative New Zealand domestic construction**

The time periods in Table 2 relate only to the initial construction of the home, and not to any subsequent renovation or remodelling work. Some of the homes in each typology have since been demolished, and some that remain may have been modified so significantly that they are no longer recognisable as part of the cohort. However, on average, homes constructed in the same period share such significant performance similarities that they can be represented by a modal home (Ryan, 2008).

The characteristics of each modal home are relevant to the operational Sustainability of the respective typology, so it is to the definition of Sustainability for each of these modal homes that we now must turn.

### 3.2.7 Defining modal home sustainability

While there are differences in the manner in which parameters (particularly transport) are attributed to homes, there is widespread international agreement that the following parameters need to be characterised in the assessment of the Sustainability of homes:

- Energy – where the amount of envelope insulation and the space and water heating are the relevant parameters, although lighting and appliance use are also of interest.

- Water – the 'three waters' potable, storm and foul water (which can be further separated into grey[3] and black[4] water) are all relevant to sustainability. However occupants have direct control over potable water (most of which typically ends up as foul water), but can only manage storm water and do not control it by volume. Consequently a measurement of potable water is appropriate.
- IEQ – which includes measures of humidity and other air pollutants. The healthy range of indoor relative humidity has been defined by Beacon as having a mean value between 20% and 70% (Easton, 2008). Frequent air changes deal with other pollutants, with 0.5 air changes per hour recommended for domestic spaces without significant moisture sources, which is provided with mechanical or passive means.
- Solid waste – being the volume of domestic waste, including organic materials, that is disposed of in the like of a weekly municipal collection.
- Materials – being the embodied energy, toxicity, off-gassing etc of materials employed in the construction or demolition of homes.
- Home management – where the decisions made by the occupants about the operation of the home can be included in an assessment of sustainability.
- Site issues – where the location of the site near to services and utilities, as well as the contribution of the vegetative cover of the site to food production and environmental coherence, are assessed.

The Homestar™ self-assessment tool implements assessment of these parameters within 52 questions, many of which will have different values given the different typologies. The actual values for each of the 15 modal homes representing the 15 typologies are presented in the Appendix (Section 7.2), together with justification for their choices.

### 3.2.8 Sustainability rating

The Homestar™ tool has been used to calculate the representative star rating for the Sustainability of the modal home of each typology. The results can be seen in Figure 1 for the Wellington climate region, representing the typical performance of each of the 15 typologies, and overall representing the current Sustainability of the New Zealand housing stock.

As seen in Figure 1, each vertical bar represents the Homestar™ rating achieved for a particular typology, being between two and four stars. The results show that all housing typologies from the early housing (prior to 1900), through to the housing cohort of the mid-1990s receive a two star rating from the Homestar™ self-assessment tool. This rating is based on the assumptions for the performance of these homes, as defined in the Appendix (See Table 4 in Section 7.2).

There are over one million homes built prior to the mid-1990s in New Zealand (Burgess and Camilleri, 2010) and these all receive a two star rating using the Homestar™ tool. Homes in the mid-2000s and the late 2000s cohorts receive a four star rating, mainly due to the higher envelope insulation levels required by the relevant building codes (e.g. the NZBC). Individual examples of homes from these typologies will not necessarily receive a two or four star rating, however all typical

[3] Grey water is the waste water from a home that is typically extracted from kitchen, laundry and bathing activities, that may have some organic content, but if used quickly and not stored for extended periods does not cause odours, or impinge upon human health through heavy levels of contamination.

[4] Black water is the discharge from a water-flushed toilet, where no separation of liquid and solid portions of biological treatment is performed.

homes in these cohorts do. When a study was performed to determine the sensitivity of the results to changes in the climate region, it was revealed that there were only minor variations, and that any change in rating is in the same direction across all typologies so the relative difference between typologies is maintained.

It can be seen that typical homes constructed prior to the introduction of envelope insulation in 1978, and homes constructed after the late 1990s, perform equally poorly on all aspects of the Homestar™ rating, with some subcategories receiving no points at all. However, typical homes constructed between 1978 and the late 1990s suffer from not meeting minimum performance requirements for the thermal performance of the envelope. This means that it becomes difficult for the home to achieve healthy winter-time temperatures without using excessive quantities of energy. As a result, a star rating of two has been achieved for these typologies, even though the home's performance in other areas could result in it obtaining a higher star rating.

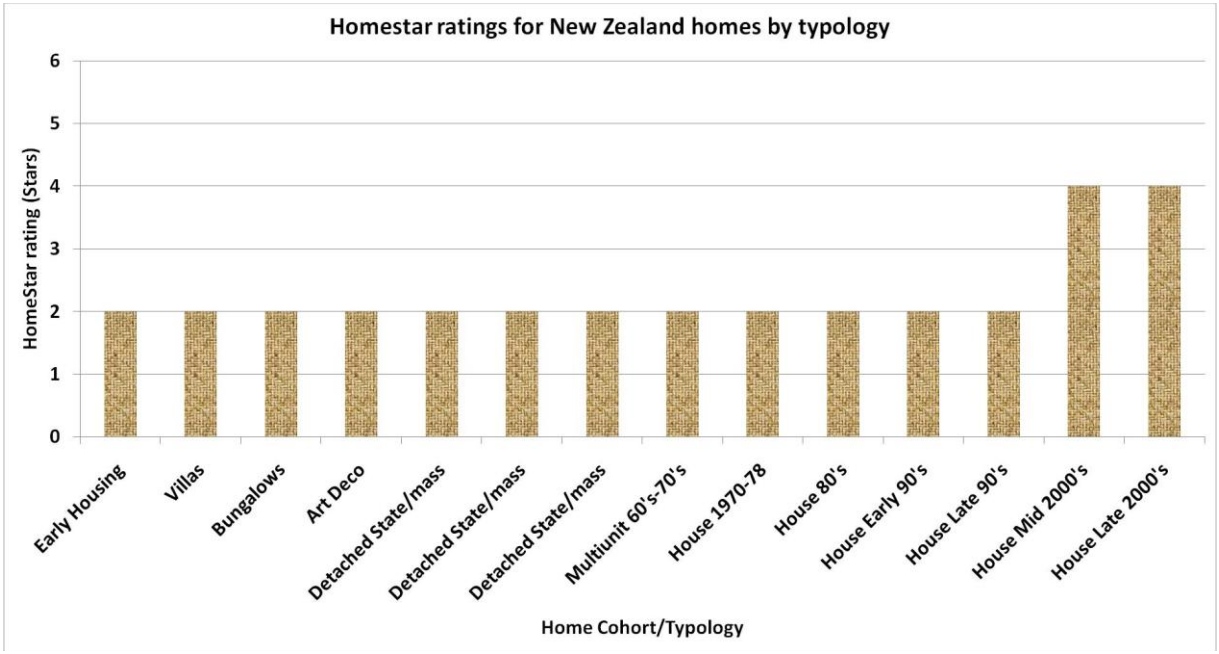


**Figure 1: Today – Homestar™ ratings for New Zealand homes by typology, representing typical current performance**

The outcomes indicate that the current level of environmental sustainability of average New Zealand housing of all typologies and ages is typically very poor when measured with the Homestar™ self-assessment metric. This also shows that there is significant room for Sustainability uplift in all typical New Zealand homes.

# 4 GOVERNMENT ASPIRATIONS AND POLICY FOR THE SUSTAINABILITY OF EXISTING HOMES IN NEW ZEALAND

The main results of this section are:

- The Sustainability targets set by central government for new homes in New Zealand are low, and there are no plans for increased stringency
- Central New Zealand government agencies have aspirations for the Sustainability uplift of existing homes, but no policy.

## 4.1 Targets for sustainability of the housing stock

It is important for New Zealand to have robust and high Sustainability targets to minimise the consumption and depletion of natural resources, and improve the embodied value (including economic) of the housing stock.

The NZBC has expectations for envelope insulation and water heating (Clause H1 of the NZBC) which sets minimum performance requirements on these aspects of Sustainability. There are no consumption guidelines used by the government or its agencies for space heating, lighting or appliance energy use, although the EECA does have Minimum Energy Performance Standards (MEPS) with mandatory labelling for some classes of appliances, with the highest energy users being systematically removed from the market. The quality of potable water is covered by the National Environmental Standards (NESs) on drinking water (MfE, 2009). The Building Act (DBH, 2004) makes the wastage of potable water an offence (s192), but there is no definition of what entails water wastage. This means that there is no legislative instrument available at central government level for minimising, or encouraging, efficient water use. This responsibility is devolved to Territorial Authorities (TAs) where water charges are typically included in the general levies rate.

### 4.1.1 New homes

The Sustainability policy targets for new New Zealand homes are contained in the performance requirements of the NZBC and in the Waste Minimisation Act (WMA) 2008. For appliances used within homes, there are also Minimum Energy Performance Standards (MEPS) which have the weight of legislation. There are a number of other Acts that have a bearing on the operation of homes, such as regulations pertinent to energy supply. However these are of second order of importance, and are not surveyed in this work. The NZBC, WMA and MEPS are the responsibility of the DBH, the MfE and the EECA respectively. For the NZBC and WMA, the legislative obligations for achieving these targets are devolved to TAs, which means that they can be applied in different ways, although they remain mandatory.

Aspirations for improving the Sustainability performance of new homes are present in the form of education about energy efficiency from EECA, However there is no encouragement (economic or otherwise) to go beyond the minimum requirements of the NZBC.

### 4.1.2 Existing homes

For existing New Zealand homes, there is no 'warrant of fitness' to ensure the continued performance of existing homes, and compliance with the NZBC is only mandatory when new construction work is performed. While technically all building work must comply with the NZBC, this is only confirmed when the building work requires a consent.

The government does have aspirations for the improvement of existing homes, most notably through the EECA where programmes including the 'Warm Up New Zealand: Heat Smart' programme are promoted. However these are non-mandatory.

The aspirations and policy of the government in regard to the Sustainability of new and existing homes in New Zealand are shown in Table 3.

| ***Agent*** | ***House Age*** | ***Instrument*** | | ***Application*** | |
|---|---|---|---|---|---|
| | | ***Policy*** | ***Aspiration*** | ***Pathway*** | ***Scope*** |
| ***DBH*** | ***New*** | *NZBC* | | *TAs* | *All new build* |
| | ***Existing*** | *NZBC* | | *TAs* | *Renovation, public risk* |
| ***EECA*** | ***New*** | *MEPS* | *Education* | *Media* | *All housing* |
| | ***Existing*** | *MEPS* | *Programmes* | *Suppliers with funding support* | *All housing* |
| ***MfE*** | ***New*** | *Waste Levy* | | *TAs* | *All new build* |
| | ***Existing*** | *Waste Levy* | | *TAs* | *All new build* |

**Table 3: Aspirations and policy of central government in regard to the operational environmental sustainability of New Zealand homes**

The data in Table 3 shows that the DBH has a policy instrument available in the NZBC, that is applied through TAs to new and existing housing. However the policy is only applicable when a consent is required for initial construction or renovations. The EECA has policies appliances (MEPS) that have a limited effect on the Sustainability of new and existing homes. However they do have aspirational, non-mandatory programmes available for existing homes through the 'Warm Up New Zealand: Heat Smart' programme.

When the aspirations and obligations of the various agencies shown in Table 3 are implemented in the modal homes (representing the New Zealand housing stock) the values of the 52 Homestar™ input parameters are changed. This results in a Homestar™ rating for each home typology that can be attributed to the policy/aspiration of each government agency. The details of these results are provided

in the following section (Section 4.2), which shows that it is only for the energy-related aspirations of EECA that there is any significant Sustainability uplift.

## 4.2 The discovery of policy and intention

The results regarding the regulatory requirements and aspirations for the Sustainability of new and existing housing stock were compiled through assessment of Acts of Parliament and the policy and aspirations of government agencies. The assessment of the relevant Acts is contained in Section 4.2.1. The impact of the Resource Management Act (RMA) 1991 on housing is then discussed in Section 4.2.2. An assessment of the roles of government agencies in Sustainability is contained in Section 4.2.3.

### 4.2.1 Acts

The Acts of Parliament that were found to have direct relevant to the Sustainability of the New Zealand housing stock were determined to be the following, which are summarised in the following sections:

- Local Government Act 2002 (Section 4.2.1.1)
- Waste Minimisation Act 2008 (Section 4.2.1.2)
- Building Act 2004 (Section 4.2.1.3)
- Energy Efficiency and Conservation Act 2000 (Section 4.2.1.4)
- Resource Management Act 1991 (Section 4.2.1.6)

#### 4.2.1.1 The Local Government Act (2002)

The purpose of this Act is to provide for "democratic and effective local government that recognises the diversity of New Zealand communities". Consequently this Act:

- provides a framework and powers for local authorities to decide which activities they undertake and the manner in which they will undertake them; and
- promotes the accountability of local authorities to their communities; and
- provides for local authorities to play a broad role in promoting the social, economic, environmental and cultural well-being of communities, taking a sustainable development approach.

The Act establishes the manner in which responsibility for local government is devolved from central government. This results in policy being applied by the 11 regional councils and 68 TAs (as of November 2010), which indicates that the Sustainability of buildings built under the aegis of different TAs could be different. The Sustainability of buildings within the different jurisdictions has not been assessed.

In relation to the Sustainability of housing in New Zealand, the Local Government Act (LGA) 2002 allows TAs to provide resources and facilities to homes, including rubbish collection, waste water management and potable water provision, in accordance with their long-term plan. The Act encourages central government agencies to support and work with local authorities to achieve community outcomes in the 78 local authorities (regional, district and city councils). The Act prevents local authorities from requiring higher performance for a building (including homes) than is required in the NZBC, has requirements for sewage management, and specifically prohibits the wasting of potable water in s 192. The Act has no jurisdiction over the provision of electric or gas services to homes, which are considered under other legislation.

#### 4.2.1.2 The Waste Minimisation Act (2008)

The purpose of the WMA is to encourage waste minimisation and a decrease in waste disposal in order to:

- protect the environment from harm; and
- provide environmental, social, economic and cultural benefits.

Harmful effects from waste include the emission of harmful GHGs from waste decomposing in landfills, and toxic leachate escaping into the ground. Waste requires valuable open space to be allocated for landfills, which are a nuisance to neighbours and limit future land use. Waste symbolises economic inefficiency and is the evidence of an unsustainable use of resources. As more waste is produced and landfill space becomes scarcer, the cost of disposal continues to rise.

The WMA provides the legislative obligation and tools to support progress toward goals within the New Zealand Waste Strategy (NZWS – MfE, 2010). One tool is a waste disposal levy, half of which is allocated to TAs proportionally to their population base.

The WMA devolves responsibility to TAs, who "must promote effective and efficient waste management and minimisation within their districts" (s 42). TAs must prepare a Waste Management and Minimisation Plan (WMMP) (s 43) that provides for: "methods for achieving effective and efficient waste management and minimisation within the territorial authority's district, including collection, recovery, recycling, treatment, and disposal services for the district to meet its current and future waste management and minimisation needs".

The WMA:

- set up the requirements for product stewardship schemes for priority products (waste streams)
- established a waste disposal levy (enacted from 1 July 2009)
- defined the requirements of TAs in regard to waste management and minimisation.

#### 4.2.1.3 The Building Act (2004)

The Building Act was developed to allow regulation of building work, the establishment of a licensing regime for building practitioners, and the setting of performance standards for buildings. This was to ensure the health and safety of occupants, and that buildings are designed, constructed and able to be used in ways that promote sustainable development. The Act requires:

- that houses comply with the NZBC
- energy is conserved, used efficiently, and that renewable sources of energy are used
- materials and water are conserved and used efficiently
- waste generated during the construction process is reduced.

The NZBC sits under the Building Act, which prescribes functional requirements for buildings and "the performance criteria with which buildings must comply in their intended use". The Act

established the DBH as the agency to operate the NZBC, which develops performance requirements for new homes, although it has no application to existing homes.

The NZBC is applicable nationwide, however as noted under the LGA, compliance with the Building Act is the responsibility of the 91 local authorities. Variation in climate, sea spray zones, ground conditions, seismicity and other factors alter the manner in which it can be applied. For example, stainless steel fixings are required for all foundation fixings in sea spray zones, but not in inland areas. This affects the environmental toxicity of materials associated with building and maintaining homes. The impact of these factors on Sustainability has not been assessed, since this work regards the operational matters and not construction or maintenance.

#### 4.2.1.4 The Energy Efficiency and Conservation Act (2000)

The Energy Efficiency and Conservation Act 2000 (EEC Act) was developed to promote energy efficiency, energy conservation and the use of renewable sources of energy. The Act was required to take into account sustainability principles including health and safety, social, economic, cultural and environmental facets for the foreseeable needs of future generations.

Under the Act sits the New Zealand Energy Efficiency and Conservation Strategy (NZEECS, 2007). The original strategy (2001) has since been revised into the 2007 version which sat under the New Zealand Energy Strategy (NZES). Both documents are currently being revised (May 2011).

The NZEECS (s 10) gives effect to the government's policy on the promotion in New Zealand of energy efficiency, energy conservation and the use of renewable sources of energy. The strategy is required to be consistent with any National Policy Statements (NPSs) developed under the RMA.

The Act established the EECA, whose function (s 21) is to encourage, promote and support energy efficiency, energy conservation and the use of renewable sources of energy by:

- advising the Minister on any matter relating to or affecting—
    - energy efficiency and conservation, and the use of renewable sources of energy in New Zealand; or
    - the functions of the Authority:
- assisting the Minister to prepare and administer a strategy;
- promoting public awareness in New Zealand of the importance of energy efficiency and conservation, and the use of renewable sources of energy;
- promoting practices and technologies to further energy efficiency, energy conservation, and the use of renewable sources of energy;
- arranging for the conduct of research, assessments, demonstrations, and studies;
- monitoring and reviewing the state of energy efficiency, energy conservation, and the use of renewable sources of energy in New Zealand;
- publishing relevant information, research, and other material;
- carrying out such other functions and duties as are conferred or imposed on it by any enactment.

The Act places no legislative obligations regarding Sustainability on central government, or on local authorities regarding the achievement of energy efficiency in New Zealand homes. The Act is only relevant to the Sustainability of the New Zealand housing stock through the uptake of the aspirations

that it contains by the agency (EECA) who is created by it. This is in contrast to the obligations that are placed upon central government in the UK by the CSH (see Section 4.3.1).

#### 4.2.1.5 The Health Act (1957)

The Health Act enforces the Housing Improvement regulations (1947) which require minimum rooms and room sizes in all houses, as well as the maintenance of the performance requirements set in the NZBC for the following aspects of a house:

- A heating device in the living room
- A sink in the kitchen
- Adequate potable water supply
- A means to bake and boil food.
- A bath or shower
- A toilet
- Windows to all habitable rooms
- Artificial lighting
- Adequate external drainage
- Gutters, downpipes and drains
- Adequate ventilation under timber floors
- No dampness
- A sewerage system
- Sound and durable materials
- Linings on all walls and ceilings, and washable floors without holes
- Houses, appurtenances and appliances kept in a good state of repair.

It also contains the following clause which prevents the requirements of the NZBC for new homes being applied more or less stringently applied to existing homes.

**Effect of Building Act 2004 on bylaws**

"(1) A local authority may not make any bylaw under this (Health) Act that purports to have the effect of requiring any building to achieve performance criteria additional to or more restrictive than those specified in the Building Act 2004 or the building code ..."

#### 4.2.1.6 The Resource Management Act (1991)

In 1991 the RMA amalgamated over 50 of New Zealand's laws relating to land, air and water resources and provided a framework for addressing environmental issues. A revision to the RMA is currently in process which covers the 1991 Act, including all amendments up to and including the Resource Management (Simplifying and Streamlining) Amendment Act 2009.

The Act is currently managed by the MfE, and its purpose is (s 5) to promote the sustainable management of natural and physical resources while:

- (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

- (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

### 4.2.2 Impact of the RMA on housing

The effect of the RMA is large and wide-reaching, and has significant implications for housing. However, to be effective for new housing, the requirements of the RMA need to be applied to the NZBC. To be effective for existing housing, the RMA needs to also be applied to services and appliances that are used or retrofitted to existing homes, or other legislation enforced.

In regard to the Sustainability of homes in New Zealand, s7 concerns the efficiency of the end use of energy, maintenance and enhancement of the quality of the environment, any finite characteristics of natural and physical resources, the effects of climate change, and the benefits to be derived from the use and development of renewable energy.

The RMA introduces NESs (s 9) which require (in s 43 and s 44) that each regional, city or district council must enforce a minimum of the same standard regarding environmental matters. Products that use water, or discharge chemicals and other substances that could present a risk to the environment, are either covered by the NESs and/or the Hazardous Substances and New Organisms Act 1996.

The following NESs relevant to Sustainability are currently in force:

- air quality standards (which have subsequently been reviewed)
- sources of human drinking-water standard.

The proposed NES for on-site wastewater systems has been withdrawn.

#### 4.2.2.1 Air quality

Fourteen NESs for air quality have been established by the 2004 amendments to the RMA (NESs relating to certain air pollutants, dioxins and other toxics). The standards ban certain activities in order to reduce the release of toxic materials such as dioxin into the air.

The standards also address ambient air quality in respect of fine particles, carbon monoxide, nitrogen dioxide, ozone and sulphur dioxide. They required regional councils to monitor air quality in areas where the ambient air quality standards are likely to be breached, and publicly report if the level of pollutants exceed prescribed ambient standards. The standards also restrict the granting of resource consents where emissions cause the air quality to fail to meet the prescribed standards.

In addition, two design standards have been adopted: the first is for new domestic wood burners in urban areas, which came into effect on 1 September 2005; and the second is for the collection and destruction of landfill gases at large new landfills to control the discharge of methane – one of the most important GHGs.

However there are no standards for the quality of indoor air, which should be within the aegis of the NZBC.

#### 4.2.2.2 Human drinking-water sources

The National Environmental Standard for Human Drinking-water Sources came into force on 20 June 2008. It requires regional councils to ensure that effects on drinking water sources are considered in decisions on resource consents and regional plans. Specifically, councils will be required to:

- decline discharge or water permits that are likely to result in community drinking water becoming unsafe for human consumption following existing treatment
- be satisfied that permitted activities in regional plans will not result in community drinking water supplies being unsafe for human consumption following existing treatment
- place conditions on relevant resource consents requiring notification of drinking water suppliers if significant unintended events occur (e.g. spills) that may adversely affect sources of human drinking water.

Other sections of the Act:

- restrict the discharge of contaminants (gas, liquid, solid, and energy) into the environment unless permitted by the NES, resource consent or regional plan
- detail responsibilities of regional councils
- detail responsibilities of TAs
- allows NPSs to be developed which enable central government to prescribe objectives and policies on resource management matters of national significance.

#### 4.2.2.3 Regional councils

The overall function of regional councils is to ensure "integrated regional environmental management". Regional councils are responsible for the management of the effects of activities on fresh water, coastal water, air and land. Regional council functions are set out in detail in s 30 of the RMA and include the management of:

- contaminant discharges
- water quality
- air quality
- natural hazards and hazardous substances
- indigenous biodiversity.

In carrying out these functions, regional councils develop and implement regional policy statements and regional plans. Regional councils are also responsible for assessing applications for certain resource consents including water permits, discharge permits and some land-use consents.

#### 4.2.2.4 Territorial Authorities

TAs (which includes city and district councils) prepare and implement district plans relating to land-use planning and development control. The functions of TAs are set out in s 31. As well as considering applications for land-use and subdivision consents based on the provisions of their district plan, TAs also manage noise and historic buildings.

TAs also control the effects of land-use on natural hazards and the risks posed by hazardous substances. The Resource Management Amendment Act 2003 provides for the maintenance of indigenous biodiversity as a TA function (as well as a regional council function).

TAs also have responsibilities under other legislation, including the issuing of building consents for home construction and alteration under the Building Act and under the LGA. They are responsible for:

- infrastructure (roading and transport, subdivisions, parks, sewerage, rubbish, water and storm water)
- environmental health and safety (including building controls, civil defence and environmental health matters)
- community well-being and development, including recreation reserves and culture.

The way in which legislative requirements are devolved by the RMA (and the LGA) to TAs is internationally unique. This devolution of responsibility has the benefit of recognising the variation in application of legislation through New Zealand, but the dis-benefit of allowing variation in compliance.

The cost of compliance may therefore be increased through each TA needing to independently develop and apply legislation in its area, rather than being able to implement central government policies.

### 4.2.3 Central government agencies

These agencies have legislative requirements placed upon them as determined by Acts of Parliament. They may also have goals developed in response to Statements of Intent.

The following agencies and departments were identified as potentially having policies that could impinge on the environmental sustainability of the New Zealand housing stock:

- Centre for Housing Research
- Department of Building and Housing
- Department of Conservation
- Department of Internal Affairs
- Earthquake Commission
- Electricity Commission
- Electricity Corporation of New Zealand
- Energy Efficiency and Conservation Authority
- Health Research Council
- Housing New Zealand Corporation
- Land Information New Zealand
- Ministry for the Environment
- Ministry of Agriculture and Forestry
- Ministry of Civil Defence and Emergency Management
- Ministry of Economic Development

- Ministry of Health
- Ministry of Social Development
- National Institute of Water and Atmospheric Research
- New Zealand Fire Service
- New Zealand Government Property Corporation
- New Zealand Historic Places Trust
- New Zealand Railways Corporation
- New Zealand Transport Agency
- Privacy Commissioner
- Quotable Value
- Real Estate Agents Authority.

These agencies have been contacted and discussions held regarding the impact of their policy on environmental sustainability or, at the least, information from the agencies has been assessed. A pro-forma was used to capture relevant housing information from the agencies, with reports available in the Appendices for the following agencies:

- Department of Building and Housing
- Ministry of Civil Defence and Emergency Management
- Housing Corporation New Zealand
- Ministry for the Environment
- Department of Conservation
- Energy Efficiency and Conservation Authority.

The information gathered from the web, and from discussions and interviews with the other agencies, was not sufficiently relevant to include in this report.

Analysis of the Statements of Intent from the agencies noted above revealed that there were only three central government agencies who had significant enough impact on the Sustainability of the New Zealand housing stock to pursue further information. These agencies were:

- Energy Efficiency and Conservation Authority
- Ministry for the Environment
- Department of Building and Housing.

The aspirations and legislative obligations of these three central government agencies were converted into inputs to the Homestar™ tool, and have already been presented in Table 3. The manner in which these data were developed is presented in the following discussion of the three agencies.

#### 4.2.3.1 EECA

The EECA is the central government agency responsible for the wise use of energy resources, including efficient energy use, and the reduction in the use of energy in buildings. The Authority was created by, and has been assigned roles under the EEC Act.

These roles are listed in Section 4.2.1.4 of the Act. However the Act does not place any legislative obligations on the EECA with respect to achieving energy efficiency in New Zealand homes.

The EEC Act does require the development of an energy efficiency strategy to be driven by EECA. The first five-year strategy was published in 2001, which sat under the NZES developed by the Ministry of Economic Development (MED). The current strategy (NZEECS - Making it Happen') was released in 2007 (EECA, 2007). It contains a detailed action plan including:

- a clearer focus on consumer (demand-side) action
- sector-based actions and targets and clear accountabilities for delivery
- improved resources
- new programmes for specific sectors such as primary production and tourism.

Consultation has recently closed on the next version (the third) to replace the 2007 strategy. This draft (released in July 2010) has less specificity with respect to 'homes' and has more generalised targets. The draft document has a slightly less precise target for energy saving in homes (4 PJ as compared to 3.6 PJ in the current strategy) and encourages private investment in energy efficiency, but provides no compliance path. The document focuses on economic development, and encourages extractive industries, but has significantly reduced content from previous versions of this document. The impression is that the document relegates energy efficiency into a subordinate place below other economic aspirations.

##### 4.2.3.1.1 EECA policy and aspirations

The NZES and the NZEECS documents articulate a policy direction, but are not policy. As noted in Table 3, EECA has no policy obligations for the Sustainability of the housing stock. However it does have requirements for appliances, and performance aspirations, as outlined in the Statement of Intent, summarised in the following:

1. All New Zealanders live in homes that:
    - are warm and dry, and
    - [are] heated efficiently with clean sources of energy.
2. Home owners choose building designs which:
    - take advantage of the sun's warmth, and
    - which incorporate efficient, clean technologies for:
        - water [heating], and
        - space heating, and

- to produce power.

3. The costs of:
   - home-scale heating, and
   - distributed generation technologies

   have reduced to a level that is commonly affordable.

The aspirations have been extracted from the EECA Statement of Intent 2010-2013 (EECA, 2010).

The summary of these aspirations have been used to develop values for the 52 Homestar™ input parameters for each typology, making the following optimal assumptions:

- the current (2011) NZBC levels of envelope insulation are used (wall, floor, window and ceiling)
- high efficiency space heating systems are used (best currently available)
- high efficiency water heating systems are used (best currently available).

The 52 values chosen to implement these can be seen in Table 7 in the Appendices. Values for the parameters which are not influenced by EECA aspirations are maintained as for the "Current State" home options, as seen in Table 4. The graph in Figure 2 shows the effect of the optimal EECA aspirations on the Homestar™ ratings of selected cohorts of the existing New Zealand housing stock.

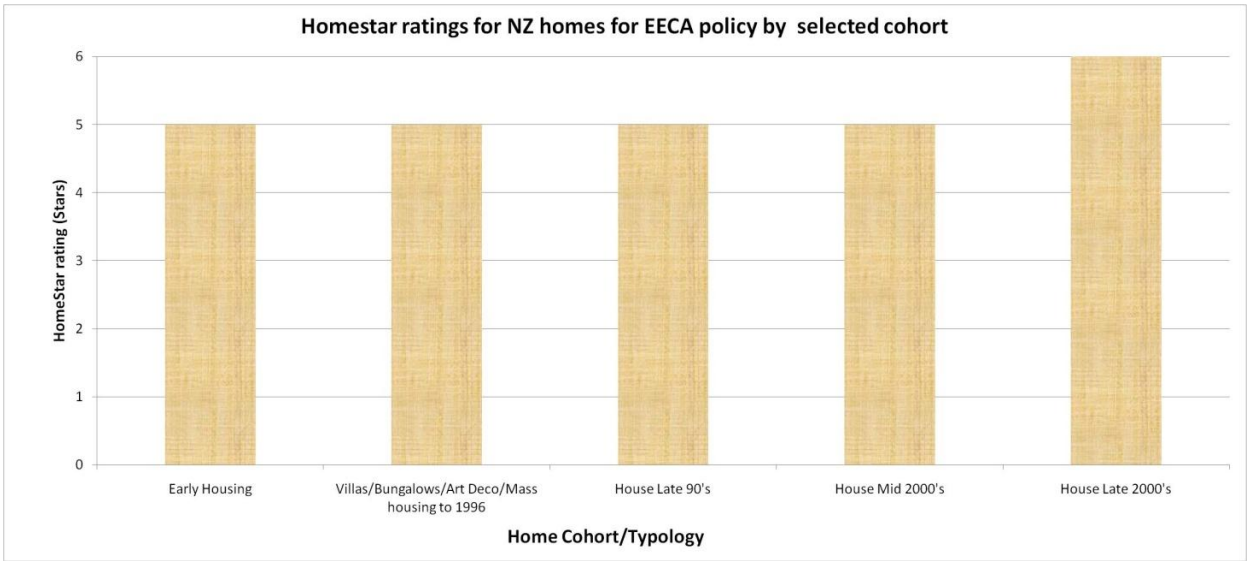


**Figure 2: EECA – Homestar™ ratings for the typologies of New Zealand homes according to the policies held by EECA**

The result can be seen that average homes of all typologies up to and including the mid-2000s could achieve a five star rating, and that typical homes constructed after this date (in the late 2000s cohort) achieve a rating of six stars. This is a good result for all typologies, being a two or three star increase over the base case of the "Today" rating (Figure 1) and a two or three star increment over the DBH rating (Figure 3). This shows that the implementation of optimal EECA aspiration as an intervention to the existing housing stock provides a significant uplift to the Sustainability of all cohorts of homes. It also recognises the significant weighting given to energy as a fundamental contribution to the Sustainability of the housing stock.

This result indicates what could be achieved if the stringency of the NZBC was increased and applied to existing homes, such that the NZBC performance minima for energy-related aspects was set at the aspirational level seen in Figure 2 for all housing. This would mean that the NZBC became an instrument for achieving the installation of highly efficient space and water heating systems, and could be made retrospective whenever a home was upgraded, or a building consent required. In this situation Homestar™ ratings of six stars could be achieved in new homes, and five stars in existing homes.

#### 4.2.3.2 Department of Building and Housing


The DBH is responsible for both the Building Act and the NZBC. This study reviews the 2004 version of the Building Act, although it is recognised that this is under review and may subsequently change.

The strategy for the DBH is to: "Improve the sustainability of the built environment so that it contributes to a strong economy, positive living environments and effective communities". The Building Act states under 'Purpose' that the key clause relating to sustainability is:

- 3(d) buildings are designed, constructed and able to be used in ways that promote sustainable development.

Under 'Principles', the key clauses relating to sustainability are:

- 4(2)(b) the need to ensure that any harmful effect on human health resulting from the use of particular building methods or products or of a particular building design, or from building work, is prevented or minimized
- 4(2)(e) the costs of a building (including maintenance) over the whole of its life
- 4(2)(m) the need to facilitate the efficient use of energy and energy conservation and the use of renewable sources of energy in buildings
- 4(2)(n) the need to facilitate the efficient and sustainable use in buildings of:
  a. materials (including materials that promote or support human health), and
  b. material conservation
- 4(2)(o) the need to facilitate the efficient use of water and water conservation in buildings
- 4(2)(p) the need to facilitate the reduction in the generation of waste during the construction process.

The DBH therefore sets minimum performance requirements for the housing stock through the NZBC, which is a legal obligation, although this responsibility is devolved to local authorities.

It is therefore a legislative requirement that all homes built in New Zealand meet the requirements of the NZBC that were applicable at the time of construction, and that all renovations (requiring consent) meet the requirements of the NZBC that are applicable at that time. The requirements of the NZBC have changed through the years, such that older homes may well have renovations performed that comply with different versions of the NZBC than those that were applicable at the time of first construction.

Also, the manner and degree to which these requirements are met are at the discretion of the different local authorities in New Zealand (currently 91, but it is expected that this number fluctuates). The fact that not all homes are maintained in a state that ensures continued compliance with the NZBC is illustrated in the results from the 'BRANZ House Condition Survey' (HCS) (Clark, 2005) which indicate typically poor maintenance levels in the housing stock. Consequently, there could be a difference between the actual average Sustainability of existing homes (as shown in Figure 1) and the Sustainability of existing homes which is intended by the NZBC.

#### 4.2.3.2.1 Effect of NZBC compliance on Homestar™ rating

The requirements of the NZBC on the Sustainability of the New Zealand housing stock have been determined for each typology of homes. The resultant values for the 52 Homestar™ parameters are presented in Table 5 in Section 7.3 of the Appendices.

The parameter values have been developed in the same way as for the "Current State" option rating as seen in Table 4 in the Appendix. However, the "Current State" values are used as the baseline where the DBH policy does not generate a value. The resultant Homestar™ rankings are shown in Figure 3. Here the typologies (as shown in Table 2) from Villa to the Mass housing to 1996 have been combined into a single bar, since the results are the same.

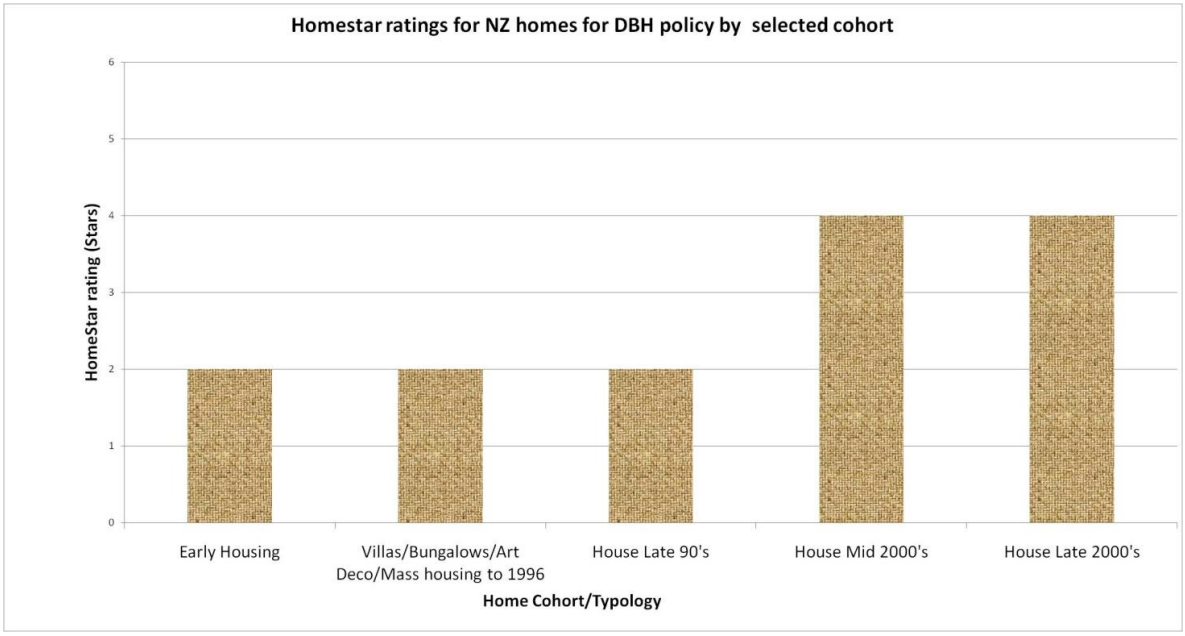


**Figure 3: DBH – Homestar™ ratings for the typologies of New Zealand homes according to the policies held by the DBH**

The results show that the modal homes that were built in accordance with the minimum performance levels of the NZBC applicable at the time of construction achieve either two or four stars using the Homestar™ tool. The cohorts from early housing to the late 1990s all achieve a two star rating,

whereas the cohorts of homes constructed in the mid-2000s and the late 2000s achieve four stars. The jump from two stars to four stars is relevant to the upgrade in the thermal envelope insulation requirements in NZS4218:1996 that was implemented in the NZBC in 2000.

The Homestar™ rating results for the implementation of DBH policy in Figure 3 are the same as the Homestar™ ratings that are found for the current state of our housing stock in Figure 1. This means that the typical current Sustainability of our housing stock is at the level required by the NZBC. This is interesting, since there is no legal requirement for this. It must be recognised that the Sustainability level required by the NZBC is very low (two stars for most typologies), which means that the level is easy to meet. Also, the ratings are not necessarily achieved due to the same values being used for all 52 Homestar™ input parameters.

It is clear from Figure 3 that if the current requirements of the NZBC were applied to the older housing stock (pre-1979) the sustainability of this older housing would be improved. However the Sustainability uplift is being driven by improvements in the energy efficiency of the housing stock (Clause H1 of the NZBC), since no other Sustainability advancements are implemented in the NZBC.

It is concluded that while sustainability is recognised at the strategic level in the Building Act, the implementation of operational environmental sustainability in the NZBC itself is weak, forming a disjunction between policy and its implementation. It also suggests that 'sustainability' is being interpreted differently in different environments.

#### 4.2.3.3 Ministry for the Environment

The MfE is the central government ministry responsible for environmental impact and monitoring, which means that the Ministry implements policy that affects the non energy-related aspects of sustainability, being responsible *inter alia* for:

- management of natural resources
- sustainable land management
- air and water quality
- management of hazardous substances
- waste and contaminated sites
- protection of the ozone layer,
- responding to the threat of climate change.

In relation to the Sustainability of the housing stock, the MfE is currently responsible for implementing the:

- Urban Design Protocol
- Emissions Trading Scheme (ETS)

- Kyoto Protocol and responses
- development of the Environmental Protection Agency (EPA)
- Waste Minimisation Strategy
- review of the RMA
- Smarter Homes website.

The MfE's Statement of Intent (MfE, 2010) indicates that the only policy direction that is applicable directly to the Sustainability of housing is to "minimise (solid) waste" – which in this context means household rubbish. This does not include liquid or hazardous wastes, or other wastes entrained in water, such as storm water. This means that the MfE has no policy in other areas related to the Sustainability of the housing stock, and does not encompass the reduction in waste of energy or of other consumed resources.

The legislative obligation with respect to Sustainability policy is devolved from the WMA and the MfE to the TAs to minimise the volume of solid waste (including organic wastes) and maximise recycling.

#### 4.2.3.4 Effect of MfE policy on Homestar™ rating

When MfE policy is converted into values for the 52 parameters of Homestar™ to describe the Sustainability of the modal homes for all typologies (see Table 6 in the Appendices) the data in Figure 4 is obtained.

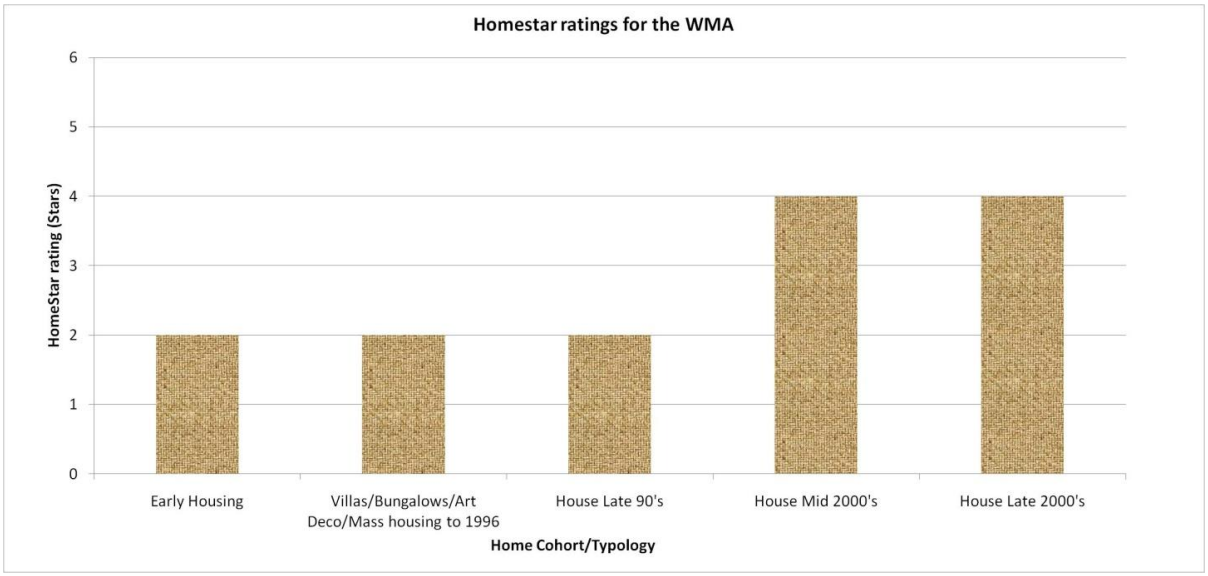


**Figure 4: MfE – the Homestar™ ratings for the typologies of New Zealand homes according to the policies held by MfE**

Since the MfE policy regards only waste, the non-waste-oriented parameters for Energy, Health and Comfort, Water, Home Management and Site from the base level "Today" rating are used, as reported in Table 4 in the Appendices.

In Figure 4, we see that all of the house typologies up to and including the late 1990s are awarded a two star rating, and then a four star rating is awarded for the more recent housing. This jump in rating is largely due to the change in home envelope insulation requirements implemented in 2004, and not

to the implementation of the WMA by the MfE in 2008. In fact, the implementation of requirements under the WMA cannot be discerned with the Homestar™ tool.

As for the results shown in Figure 1 (typical current performance) and Figure 3 (NZBC compliance), the modal homes from all typologies in Figure 4 fail to score well on all categories (except waste management). In particular, they fail to adequately manage moisture (lacking mechanical ventilation from the bathroom and kitchen) and are incapable of maintaining adequate internal space temperatures.

The result is that the current MfE policy does not provide uplift to the Sustainability of the housing stock.

#### 4.2.3.5 Policy – other agencies

Some central government agencies have significant housing stock on their asset registers and therefore have an interest in maintaining the value of these assets through maintenance and upgrades. These agencies are noted below. While they cannot set policy that is applicable to all the New Zealand housing stock, they are noted here since some of their policy may affect the policy of the other agencies:

- The Housing Corporation of New Zealand (HCNZ) is the largest landlord in the country with a portfolio of 69,000 homes on their asset register. Consequently HCNZ policy has a significant effect on the rental market for existing homes. The former minister of Housing, Steve Maharey, released the 'New Zealand Housing Strategy: Building the Future' in 2005 (HCNZ, 2006). However, since the change in government in 2008, the document is under review and discussions with HCNZ revealed that it was not being actively used. Consequently it has not been assessed in this work.
- The Department of Conservation (DOC) maintain 136 houses around mainland New Zealand and its offshore islands, and hundreds of tramping huts in remote locations, often with no access to the electricity grid. DOC has responsibility for the natural environment in New Zealand, which is influenced by the presence of housing, but they have no statutory obligations relevant to housing.
- The Ministry of Agriculture and Forestry (MAF) have some residential stock on their books, and like DOC have an interest in maintaining these assets. However they have no statutory obligations regarding the housing stock.

Other agencies have indirect effects on the Sustainability of the housing stock such as:

- The Ministry of Civil Defence and Emergency (MCDEM) has a post-disaster recovery role, and is interested in the resilience of the housing stock. This Ministry could influence new build policy, since disaster recovery would be significantly affected by the materials, processes and technologies implemented at new build and renovation. However they have not been included in the assessment since their policy affects so few of the Homestar™ parameter values.
- The Department of Internal Affairs (DIA) have responsibility for the LGA, which influences district plans at local authority level and therefore impacts on the sustainability of housing,

- The Electricity Commission have now been partially subsumed by the Electricity Authority (November 2010) and are interested in improving the energy efficiency of domestic electricity use through the EECA. They are not dealt with separately in this work.
- The National Institute of Water and Atmosphere (NIWA) provide research to the DBH and other agencies to help develop NZBC requirements relating to water and air, but have no statutory obligations regarding the Sustainability of the housing stock.

The policy and aspirations of central government agencies should have a role in providing uplift to the Sustainability performance of the housing stock given the government's stated commitment to sustainability. However the results of the previous sections show that this is minimal, with the exception of the aspirations of EECA. The Homestar™ rating results for all three agencies are plotted on the graph in Figure 5 alongside the Homestar™ ratings for the current typical performance of the modal home in each typology.

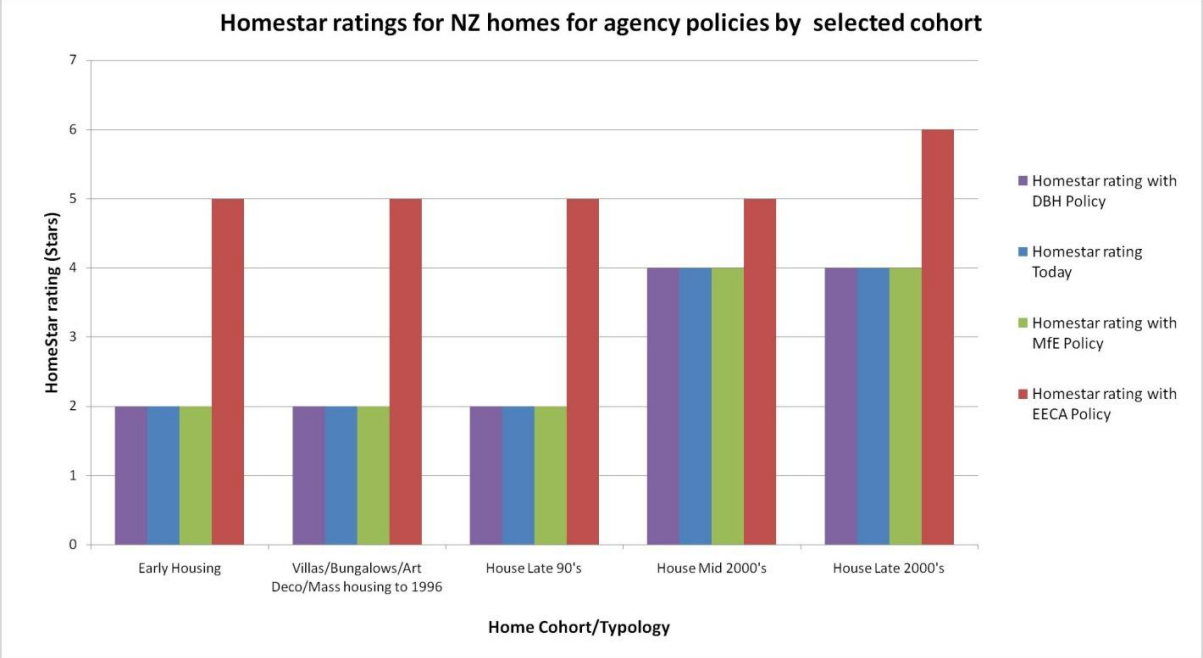


**Figure 5: All ratings – Homestar™ ratings for the typologies of New Zealand homes according to the policies held by EECA, DBH and MfE compared with the typical existing rating**

It can be seen that the optimal EECA aspiration (which implements high levels of energy efficiency only) provides the greatest sustainability uplift to the New Zealand housing stock. The EECA aspiration consistently ranks several stars above the results for the implementation of the DBH or MfE policies. While the Homestar™ ratings for the MfE and DBH policies are the same, this is for different reasons. That is, the rating of two stars in the late 1990s cohort for a modal home implementing the DBH policy is obtained with different values for the 52 Homestar™ parameters than for the same modal home implementing the MfE policy in the late 1990s. The results also indicate the gap between the current state of our housing and the achievable aspirations of the EECA.

In most cases the Homestar™ rating is limited to two (by the operation of the tool) since a minimum thermal performance has not been achieved. For the homes in the mid-2000s and the late 2000s cohorts, both the rating for a 'typical' home under the "Current State" option, and the ratings for the DBH and MfE policy implementations increase to four stars. On the other hand, the EECA policy rating remains at five stars for the mid-2000s and then jumps up to six stars for the late 2000s. This

reflects the implementation of requirements for increased thermal insulation in the envelope of homes based on the release of NZS4218:2004, and NZS4218:2009, with implementation starting in 2008 through Clause H1 of the NZBC. The resolution of the Homestar™ tool is too coarse to resolve any other improvements in Sustainability.

The difference between the optimal policy implementation of the EECA and the requirements of the NZBC (DBH) is shown in Figure 6.

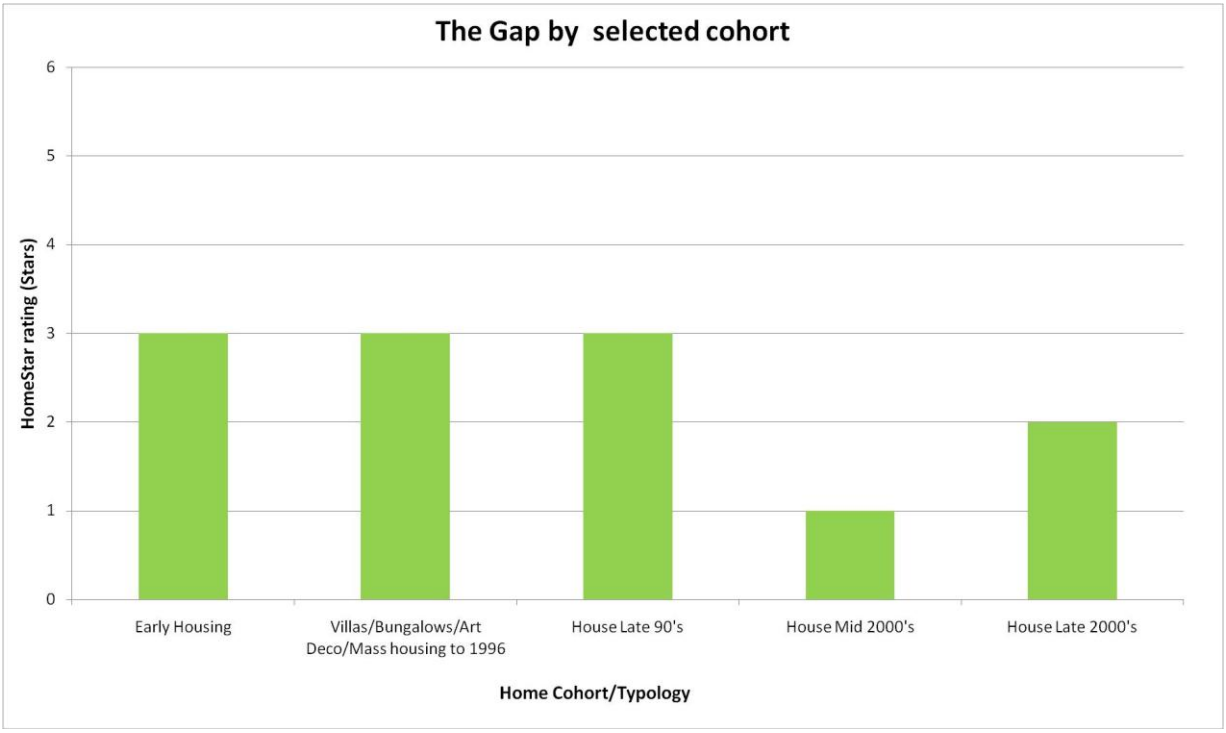


**Figure 6: The gap – Homestar™ rating differences for all typologies of New Zealand homes between optimal EECA policy and NZBC requirements**

The data in Figure 6 shows that the size of the gap between the intervention policy which produces the highest Homestar™ rating (that of EECA) and the requirements of the NZBC for the modal homes. The values vary between one and three stars, depending on typology, with the gaps being larger in earlier cohorts. This indicates the potential for Sustainability uplift purely on the basis of energy efficiency improvements due to EECA aspiration is significant for the approximately 1.5 million homes that were constructed prior to 2004 (three stars), but less significant for more recent homes.

### 4.2.4 Most 'favourable' policies

Although each agency has their own jurisdiction, separate strategies and policies, they do have the opportunity to work together to achieve sustainability uplift in the housing stock.

Table 8 in the Appendices presents the values of the 52 Homestar™ parameters for each of the modal homes if the most favourable Sustainability policies and aspirations of the DBH, EECA and MfE are applied together to existing homes. The resultant Homestar™ ratings are shown in Figure 7.

It can be seen in Figure 7 that the first two bars (representing the cohorts from early housing through to 1996) have all been awarded five stars according to the most favourable policies and aspirations of the DBH, MfE and EECA. This is the same result as for the optimal EECA aspirations in isolation. The next three cohorts have received six stars for the combined policy/aspiration. Again, this is the same result as for the optimal EECA aspirations in isolation seen in Figure 2 and Figure 5. This means that the application of MfE and DBH policies has provided no further Sustainability uplift to homes of typologies prior to the late 1990s (approximately one million homes).

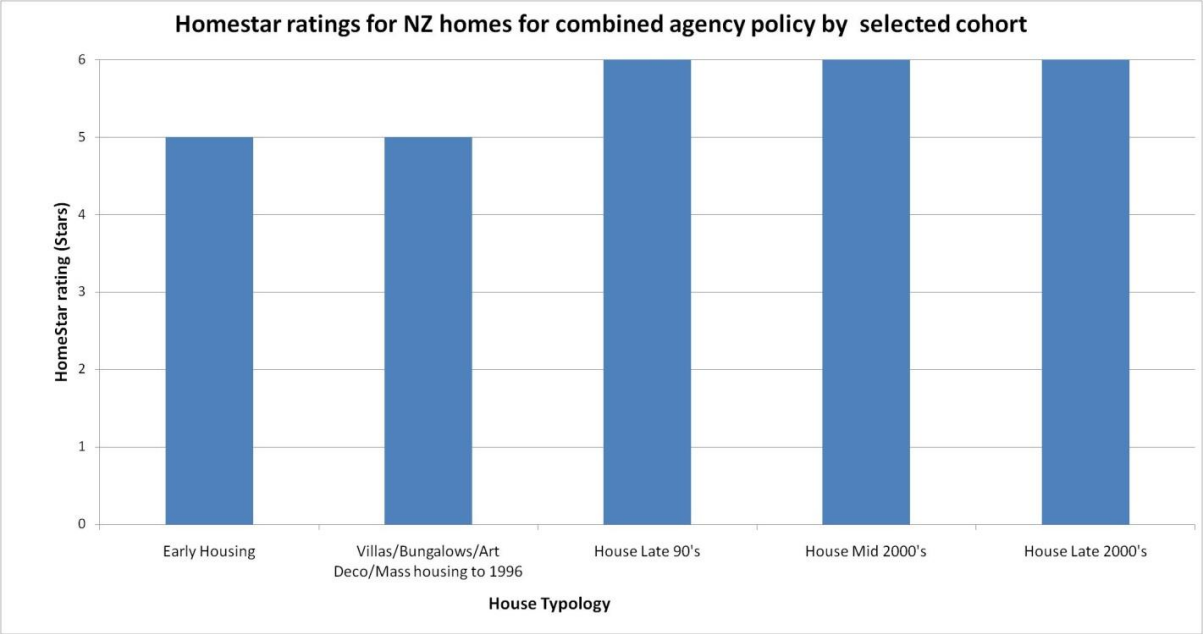


**Figure 7: Combined ratings – Homestar™ ratings for the typologies of New Zealand homes according to the combination of the most favourable policies held by the DBH, MfE and EECA**

However the addition of MfE and DBH policies to that of the EECA is sufficient to lift the rating of the cohorts of homes from the late 1990s and the mid-2000s to a six star rating. It must be noted that there is no instrument available to achieve the application of the combined policy, and no cost benefit assessment has been made. It unlikely that the development of a new instrument to allow the application of combined policies will be cost effective, particularly since most of the Sustainability uplift is credited to the use of optimal values with a single agency – the EECA.

A six star rating indicates a significant level of Sustainability, and shows that significant uplift in the Sustainability of the New Zealand housing stock can be achieved for a large proportion of this stock, which contrasts with the existing levels of two and four stars.

## 4.3 International comparison

Other western countries (including Australia, the US, Europe and the UK) have introduced instruments to both measure and/or regulate the sustainability of their domestic construction. The closest example to Homestar™ is the CSH that has been developed in the UK.

### 4.3.1 UK (Code for Sustainable Homes)

The Code for Sustainable Homes (CSH) is the document used in England, Wales and Northern Ireland for the sustainable design and construction of new homes. The CSH aims to reduce carbon emissions that are attributed to the operation of homes, and so create homes that are more sustainable. The CSH is mandatory for new build homes, and the English government intends to use it to ratchet up the requirements for sustainability. It measures the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. It covers Energy/$CO_2$, Water, Materials, Surface Water Run-off (flooding and flood prevention), Waste, Pollution, Health and Well-being, Management and Ecology. However, the carbon emission requirements within the CSH have been incorporated into Part L of the building regulations, which effectively means that it is a compliance path to the compulsory requirements of carbon reduction in UK domestic construction. The New Zealand government lacks such a tool.

The English government has committed to a target that all new homes must meet a zero carbon standard by 2016, which equates to the highest level of the CSH – Level 6. Interim targets have been set, and include domestic construction meeting CSH Level 3 in 2010 and by 2013 meeting CSH Level 4.

Between April 2007 (when the CSH was adopted) and September 2010 over 36,000 homes were designed to meet the CSH, with 13,000 homes completed by then. The majority of the homes have been awarded CSH Level 3 (31,000 homes), with 287 homes being awarded six stars at the design stage.

### 4.3.2 Comparison to Homestar™

While the CSH uses six stars, the self-assessment version of Homestar™ uses 10; the nine categories from the CSH have been covered in seven with Homestar™. The same issues are measured e.g. where the CSH makes flood prevention explicit, Homestar™ addresses on-site storm water management. The self-assessment version of Homestar™ apportions 25% of the credits to the category referred to as 'Energy' which includes assessments of space and water heating, lighting and refrigeration. A further 23% of the credits are apportioned to the 'Health and comfort' metric, which includes assessment of other energy metrics including solar gain, envelope insulation, infiltration and ventilation. The end result is that both the Homestar™ tool, and the UK tool, apportion approximately 40% of the credits to energy. There are minor differences in the attribution of credits in the other metrics because of the differing importance placed on aspects such as potable water, storm water management and waste, due in part to the different means of characterising home performance.

### 4.3.3 Local application of the CSH

The rating of a UK home with the Homestar™ tool, and the rating of a New Zealand home with the UK tool, is unfortunately not viable. The two tools cannot be directly compared. The most significant reason is that some of the metrics employed in the CSH (e.g. the hot water use algorithm and the solar energy harvesting) have been developed specifically for the housing and appliance typologies, demands, social behaviour and climatic conditions pertinent to England, Wales and Northern Ireland. These are not applicable in New Zealand. Given that the emission factors for the generation of consumer energy (electricity and gas), and the energy sources (nuclear, coal, gas) in the UK are different to those available in New Zealand, the tool would need to be significantly altered to allow a direct comparison, rendering the comparison void.

However, the intent of Homestar™ and the intent of the CSH are aligned in that they both encourage environmental sustainability in the UK housing stock, and have stretch targets to reward high performing homes with high ratings. The implication (and design of the tools) is that 10 stars under the Homestar™ programme would be equivalent to CSH Level 6 and that both ratings would achieve similar aims in Sustainability. The main dissimilarity is that the CSH is designed only for the rating of new construction, whereas Homestar™ is designed both for existing and new housing.

# 5 Discussion

The results of this study reveal that there is a vacuum in central government policy regarding the operational environmental sustainability (Sustainability) of the new and existing New Zealand housing stock. However energy efficiency (a subset of the Sustainability of the housing stock) should be improving due to the operation of non-obligatory programmes. Specifically there are policy omissions in the following areas for both new and existing housing:

- potable water consumption and management, where in most of New Zealand water rates are not levied on actual consumption of potable water, but apportioned according to the number of toilet pans on each rateable domestic site, or simply the number or rateable sites
- organic waste management and disposal – where liquid wastes with significant organic content are directed into sewage systems, and solid organic wastes are sent to landfill
- indoor moisture management – where the presence of windows are sufficient to indicate that ventilation is possible, irrespective of whether they are opened or not
- concentration and emission of volatile gases – from building materials, internal joinery and furnishings
- site issues – regarding vegetative cover and distance from facilities.

There is policy (NZBC) about the energy efficiency of new homes, but there is none regarding the energy efficiency of existing homes. The policy gap is filled with the aspiration programmes of the EECA, which are helping to elevate the thermal performance of housing to the current levels of the NZBC.

The DBH has made changes to the stringency of the NZS4218 requirements based on economic cost benefits, such that they have reached the current economic limit for improving the Sustainability of the new New Zealand housing stock through increased energy efficiency (as seen in the increased levels of envelope insulation required in the 2004 edition of NZS4218.) However, the external costs pertinent to environmental impact have not been included in their assessment. These external costs include the costs of the mitigation of climate change, and the restoration of the environment following

damage by extractive industries. While the ETS is currently the major instrument for the internalisation of environmental costs, the scope of the ETS is limited, and is unlikely to change the economic equation significantly until:

- energy costs rise significantly
- the real costs of emissions are included in the ETS.

In addition, other instruments are required to manage the costs of environmental restoration due to the actions of extractive industries. This is unlikely to occur until environmental sustainability is recognised as a vital issue by central government.

If the government were to also place importance on the non-energy related aspects of the Sustainability of the housing stock, different priorities would be needed to facilitate a coherent uplift in the Sustainability of existing homes. The DBH are focussed on new build, and their regulatory instrument (the NZBC) is not applicable to existing homes. However, since the DBH has increased the stringency of the NZBC over time (mainly in insulation requirements) they have a range of performance requirements for the housing stock available that could be used to bring Sustainability uplift. Instruments could be designed for all areas of Sustainability in concert with the non-regulatory instruments that EECA are using to achieve uplift in the energy efficiency area.

If requirements for Sustainability uplift beyond energy efficiency were incorporated into the NZBC and triggered whenever a building consent was required for alteration or additions, or if a 'warrant of fitness' was required for all housing, then the NZBC could be used as an instrument of Sustainability uplift for existing homes as well as for new homes. This could be achieved if the NZBC included performance requirements for IEQ, the volume of potable water used, material toxicity, and also to encourage native vegetative site cover for reduction in storm water run-off. Alternatively, the MfE could develop instruments to implement policy on the use of materials with low environmental impact, potable water use and storm water management for homes and building sites.

Work needs to be progressed to determine the best instruments and agency to develop such policy, and how it is best implemented.

## 5.1 Devolution of legislative requirement

There is a tendency for central government in New Zealand to devolve the responsibility for policy enforcement regarding the Sustainability of the housing stock down to regional or local government, rather than retaining it at the central government level. As noted earlier, this is unique internationally. Examples are present in the WMA, where compliance is enforced by local councils (not regional or central agencies), the NZBC (where TAs assess compliance), and the RMA (where consents are assessed by TAs unless they are "called in" and dealt with by the MfE). This has the effect of reducing the level of central control over policy, and providing for significant variation in levels of compliance.

The Sustainability policies that do exist (WMA, NZBC) represent blunt instruments. However, central government agencies have developed better tuned aspirational instruments to implement energy-related goals, such as the 'Warm Up New Zealand: Heat Smart' programme which has had considerable uptake.

# 6 Conclusions

- **There is space for significant uplift in the operational environmental sustainability of the New Zealand housing stock**

This stock has a significant environmental impact, with typical homes scoring two out of 10 stars for their operational environmental sustainability using the new Homestar™ sustainability tool. Typical homes constructed after 2003 manage to score four out of 10 stars, but there are only 60,000 of these (out of 1.6 million), and only around 150,000 people (out of four million) live in them. Improving the operational environmental sustainability of the housing stock is vital to reduce the impact on the environment, health and comfort of the population, and demand on resources.

- **The New Zealand government chooses not to regulate for sustainability**

New Zealand has low policy targets for the sustainability of new homes, and there is no planned future pathway for uplift. While sustainability is recognised at the strategic level in the Building Act, the implementation of environmental sustainability in the NZBC itself is weak, forming a disjunction between policy and its implementation. For existing homes, there is no uplift policy. There is aspiration in the energy efficiency area, but this has no legislative weight.

- **Non-mandatory, aspirational targets promoted by the EECA for improving the energy efficiency of homes are successful at creating uplift in operational environmental sustainability**

The non-legislative aspirations of the EECA in the energy efficiency area are having success in providing sustainability uplift to the existing housing stock. This is significant, since space heating is only responsible for one-quarter of the Homestar™ rating used to assess sustainability, and yet EECA's Warm Up New Zealand: Heat Smart programme could provide sustainability uplift from two to five stars.

- **Investigation into targets and policies for other sustainability indicators could significantly improve the operational environmental sustainability of New Zealand homes**

The sustainability of New Zealand homes could be improved through legislative or non-legislative uplift programmes in other areas of environmental sustainability, and appropriate instruments to achieve this should be investigated.

As is happening in the UK currently for new homes, and for the energy performance for all homes at point of sale in Europe, mandatory and optional transformation programme to ratchet up the environmental sustainability of New Zealand's homes with firm dates and targets should be investigated.

# 7 Appendices

## 7.1 Homestar

Homestar™ is a tool developed by a New Zealand-based consortium (including industry, academia, government and research providers) in this country to create a common language and assess the environmental sustainability of homes. Based on a series of 52 multi-choice questions, the tool automatically calculates the consumption and production of energy, water, waste and site conditions, against a series of Sustainability metrics. Appropriate weighting is given to each of the parameters, which are then used to reward levels of sustainability with a star rating of between one (poor) and 10 (exemplary). The Homestar™ ® tool is applicable to both existing and new build housing.

The Homestar™ tool has three incarnations;

- the self-assessment tool is available online
- a 'Homecoach' version where a trained assessor assists in the assessment
- a certified tool, where a professional person performs the assessment which has a verified output.

While the Homecoach and certified versions offer more robust Sustainability analysis, the self-assessment version of the tool is used here since it is free and available online, and is capable of accepting average values for all input parameters to represent the performance of typical homes.

This tool automatically calculates your self-assessed provisional rating based on how energy and water efficient, healthy, comfortable and sustainable your home is. You will get a provisional Homestar™ rating on a scale of 0 to 10 stars – most existing New Zealand homes would be between one and five stars so there is always room for improvement. You will also get a report that recommends the best ways to improve your home's performance. You can prioritise this list to suit what is important to you and your family – by cost, for example, or health and comfort benefits.

The tool is divided into six categories: Energy, Health and Comfort, Water, Waste, Home Management and Site. These categories were chosen following a review of international and national rating tools and in discussions with the Homestar™ Technical Advisory Group (TAG). These categories form the key foundations of the tool, and meet the aims and objectives of Homestar™.

There are thresholds (at two stars and four stars) which homes cannot exceed until they meet minimum requirements for thermal and moisture performance.

This tool implements all the requisite metrics for Sustainability of interest to this project, which allows the current level of Sustainability of the New Zealand housing stock to be portrayed with the Homestar™ tool.

A small part of the rating tool rewards non-permanent fixtures of the home such as fridges, freezers, dishwashers, compost facilities etc. If these are removed (for instance when the home changes occupancy) this could affect the star rating of the home. However the same assumptions have been made in all cases so that robust comparisons can be made in this work.

## 7.2 'Current state' of modal homes for all typologies

**Table 4: Modal home rating justification – values for the parameters for the 52 Homestar™ self-assessment questions for the modal home of all 15 New Zealand home typologies in their typical current state**

| Aspect | Justification for values for modal homes in their current state (2010) |
|---|---|
| House age | |
| Floor area | The data from the 2005 HCS provides the average floor area of a home of this era. Since the Homestar™ inputs are quantised, effectively the first three cohorts all fall into the third size bracket of between 150 and 199 m², 'Art Deco' and the cohorts up to the 1960s-1970s fall into the second bracket of 100 and 149 m², the muti-units are under 100 m², then the others up to the mid-2000s are all between 150 and 199 m², and the last two cohorts are between 200 and 249 m², being 200 and 205 m² respectively. |
| Bedrooms | The data found here (http://www.hnzc.co.nz/hnzc/web/research-&-policy/housing-research-&-evaluation/housing-research-&-evaluation_home.htm) indicates that the average number of bedrooms in New Zealand homes is three. This figure is used for all cohorts. |
| Storeys | The information in the Beacon report (Ryan et al, 2008) indicates that the average number of storeys in a home of this era is one. This is the case for all average homes, except for homes in the 1970s and 1980s where one-and-a-half storeys are used to represent an average home. |
| Space heater (main type used) | An open fire is advised by Ryan et al (2008) as being present, and potentially the main heater in the cohorts from early housing through to the 1960-1970 mass housing eras. The same source is used to justify the choice of "Fixed electric" space heating for the multi-unit cohort, "Wood burners (old)" for the housing from the 1970s through the 1980s, "Portable gas/LPG or electric heaters" are used in the early and late 1990s cohorts, then heat pumps in the mid and late 2000s cohorts, with the latest cohort being energy star rated, given the significant brand recognition of the energy star and its availability in the heat pump market. |
| DHW (main water heater) | Electric storage water heaters are used as the water heating device for all cohorts since the 2004. The HCS reports 75% of homes with electric storage domestic hot water (DHW) systems. |
| Cylinder wrapped? | No cylinder wrapping is used since the HCS does not indicate that this is a feature of an "average" home. See also cylinder age justification. |
| Cylinder age | Post-2004 cylinder ages are indicated, given the general default assumption that DHW cylinders have an average 15 year life expectation (Isaacs et al, 2010). The HCS says 41% are up to 10 years old, and 52% are B grade. |
| DHW pipes insulated? | Lagging has been used for the first metre from the DHW since the 1950s, although some homes have full pipe insulation and some have none (Isaacs et al, 2006). The recommendation for lagging of at least the first metre of hot water piping is found in early versions of NZS4305:1996 'Energy efficiency – domestic type hot water systems'. |

| | |
|---|---|
| Light bulb types used? | The work performed in the 'Home Lighting Survey' (Burgess and Camilleri, 2009) has been used to provide the inputs to this parameter, where standard bulbs are used in all cohorts up to the late 1990s. Fluorescent (compact or tube) are also used from the 1970s in all later eras, halogens (MR16-type) are also included from the early 1990s, and while not found in the 'Home Lighting Survey' work, marketing of LEDs in electric supply material has increased significantly, such that LEDs are also incorporated in the late 2000s cohort. |
| Fridges/freezer number? | (Isaacs et. al. 2010, p.192) show that the average number of refrigeration appliances in New Zealand homes is 1.99, so the value of two will be used. |
| Oldest fridge/freezer age? | The average life expectancy of a fridge is over 10 years, so 11 years is used as a default to signify over 10 years old. This is excepted for the latest cohort (late 2000s) where we assume that the owner of a new home will install a new fridge that will be under 10 years old. |
| Renewable generation on-site? | Ryan et al (2008) show that small numbers of homes have solar DHW or Photo Voltaic systems( PV's), such that the average home does not. Consequently the parameter is "No". |
| Window size | The 'HERS Home Plans' report for EECA (Buckett and Burgess, 2007) indicates that window sizes for the cohorts early housing, Villas and Bungalow, and the 1930-1950 mass housing should be "Small". "Medium" is used for the Art Deco cohort, and for all the other cohorts except for the 1979 to 1996 cohorts, which use "Large". |
| Window orientation | Windows were originally oriented to the street (Ryan et al, 2008) were oriented to the sun for a short time with state housing, but now are dependent upon orientation and size/shape of sections. Consequently an average must be an even distribution of windows. |
| Solar access | As for the window orientation, an average result is "Some". |
| Window type | Aluminium was introduced as a window framing material in the late 1960s, and became the majority window frame in the late 1970s as shown in the 'Multi-Paned Windows' report (Burgess and Bennett, 2006). All cohorts before this time have single-glazed timber windows. All others are aluminium-framed windows, with the cohort after 2008 having double-glazed aluminium windows. |
| Curtains (thick on all windows?) | No information has been sourced to provide guidance on the type of curtaining used, so the conservative default of 'None' has been used. |
| Ceiling insulation (how much?) | Around 33% (on average) of the heat loss from an uninsulated home can be through the ceiling and roof, 25% through the glazing, 20% through the walls, 13% through the floor, and 9% through air leakage.[5] For a home insulated to levels required after 2007, the figures are approximately 8% through the ceiling and roof, 48% through the glazing, 12% through the walls, 16% through the floor and 16% through air leakage. The amount of envelope insulation is therefore determined by the period of initial construction, although insulation is readily retrofitted into ceilings, and less commonly floors, and occasionally walls and windows.<br>The HCS reports that 59% of New Zealand homes have inadequate thickness of insulation to meet relevant codes. However the quantisation of inputs available mean that a 90 mm insulation thickness (see also the |

[5] http://www.smarterhomes.org.nz/design/insulation/

| | |
|---|---|
| | problem comments below) is used for all cohorts up to the mid-2000s where a 120 mm thickness is used, and for the late 2000s where the 2008 NZS4218 Code requirement is applied. |
| Problems in insulation | The HCS reports that defects in the installation of ceiling insulation are common, which reduce the effective R-value of ceiling insulation to the appropriate level (Clark et al, 2005). The number of defects has reduced over time as reported in Walford et al (2006: Fig 3) and this, coupled with the information in Ryan et al (2008) has been used to degrade the performance of the ceiling insulation to the appropriate level. |
| Recessed lights (number present?) | The downlights report for EECA (Burgess et al, 2010) provides information about the number of recessed downlights that are present in New Zealand housing. This number gives an average of 12 downlights in pre-2000 homes, and more after this date. Homestar™ has bands of up to 10 recessed downlights. Have used half a normal distribution function to allocate numbers of downlights to cohorts to achieve an average of 12 for pre-2000 homes. Any inaccuracies are ameliorated due to the quantising of Homestar™ on the threshold of five. |
| Wall construction type | Ryan et al (2008) provide data indicating that, on average, all homes have timber framing, except for the multi-units of the 1960s to 1970s where we will assume that on average concrete block is used. |
| Wall insulation present? | The NZBC requirements for wall insulation thickness/R-value with the implementation dates of NZS4218 have been used. The lack of significant upgrading (renovation) of the wall insulation value is provided by Ryan et al (2008) |
| Thermal mass – are walls exposed to sun and heavy? | The information in the Beacon report (Ryan et al, 2008) indicates that the average internal walls are light timber frame. |
| Air-loose window | Timber windows are not tested to NZS4211 airtightness requirements (Burgess and Bennett 2006). As for Al windows, they degrade over time. Bassett, 1986, Therefore all windows that are in homes of over 15 years of age are deemed to be potentially air-leaky , and contribute to undesired air infiltration. |
| Timber doors | As for windows. |
| Strip floors | Strip floorboards started to disappear in the late 1960s. Ryan et al (2008) indicate that concrete then became the predominant flooring material.Thus, all cohorts up until the 1950s are rated with strip flooring, then the multi-units of the 1960s used concrete, the 1970s homes used chipboard, and later homes used a mix including particle board and concrete. |
| Open fire | As for the home heating choice. |
| Draughts – is draughty construction used? | This is the combination of the windows, doors, floors and fireplace presence indicating severity of air infiltration, as discussed above. |
| Floor material | See above. |
| Concrete insulation | No insulation was used in concrete floors until recent times, and then on average we still have no insulation (Ryan et al, 2008). |

| | |
|---|---|
| Timber insulation | As for concrete flooring, until recently no insulation was used in timber floors and they are no longer the average construction type, so no cohorts with timber floors need insulation (Ryan et al, 2008). In addition Buckett and Burgess (2007) and the HCS survey results from 2005 indicate that 70% of homes have no underfloor insulation. |
| Foil insulation problems | No insulation used, so no problems possible. |
| Bulk insulation problems | No insulation used, so no problems possible. |
| Complete coverage? | No insulation used, so no complete coverage possible. |
| Solar access to the floor | For small and medium-sized windows, it is not possible for a third of the floor to be illuminated by the sun, so the result for these cohorts must be "No". For the cohorts with large windows (the 1980s and early 1990s) there is insufficient information available on which to base an average result, so we must use the most conservative result of "No". |
| Underfloor damp? | Concrete floors cannot have damp subfloors, and although not all concrete slabs have a damp proof membrane (DPM) we assume that concrete floors do not contribute to dampness, but that all cohorts with timber subfloors are damp. This is justified as follows – the HCS in 2005 found that: 38% of homes had subfloor framing with moisture contents at 18% or above, which is recognised as the threshold for decay; 62% had inadequate ventilation; and 91% had unprotected sub-floor ground. However the HCS also reports that timber with a moisture content lower than 18% may still be subject to decay. It has been assumed that since at least 91% of all subfloors could be damp at some time, all subfloors will be assumed to be damp for the purposes of this work. |
| Vented rangehood? | Rangehoods were available from the late 1960s (Ryan et al, 2008) but are not all ducted to the outside. Therefore on average we must take the conservative option and select "No". |
| Vented bathrooms? | Vents were installed in wet areas including bathrooms, toilets, kitchens and laundries since from the 1980s (Ryan et al, 2008) but were not all ducted to the outside, or necessarily used, so that they may not have contributed to the removal of significant quantities of moisture. Therefore on average we must take the conservative option and select "No". |
| Outdoor covered washing line? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Rain water tank? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Shower flow rate max | ANZHERS Hot Water Rating Tool 2008 (Burgess, 2007) targets 9 L/min, with 10 minute shower times. The 2005 HCS says 62% of homes have a 6-12 L/min shower flow rate. Skewing a normal distribution for this gives us a predominance of higher flow showers pre-1990, which indicates that the mid-1990s would be an appropriate period to mark the change from average shower flows of over 9 L/min to under 9 L/min. |
| Toilet flush volume | Dual flush was introduced in the 1980s, new 9/4.5, 6/3 etc dual flush was introduced in the 1990s. See http://www.waterrating.gov.au/products/index.html. Therefore with information provided from bathroom marketing information we can estimate that cohorts up to the early 1990s had a standard flush, the early 1990s had a mix of standard with the old dual flush, then the late 1990s saw a mix of old and new dual flush cisterns, which became mainly the newer more efficient dual flush options in the mid-2000s and onward. |

| | |
|---|---|
| WELS dishwasher | WELS was introduced in New Zealand progressively from the mid-1990s and is used to rate an increasing number of water using appliances. Dishwashers became commonplace in the 1980s, after being common in the US from the 1970s. See http://www.fisherpaykel.com/ 2007 WELS applies to dishwashers. Average lifetime is 16 years – (EES, 2008) Thus, due to the lack of additional information we will choose a dishwasher with a three star rating for all cohorts. |
| WELS clothes washer | 2005 saw the introduction of WELS clothes washers. Average life expectancy is 12 years – (EES, 2008) Given this information we choose a rating of three stars for the water efficiency of current washing machines in all cohorts of homes. |
| Grey water system present? | Early grey water systems were manual, whereas modern grey water systems are reticulated into the domestic plumbing systems. Neither are commonly found in New Zealand homes now, so all cohorts are rated with no system. |
| Recyclable storage inside? | It is assumed that average homes with a floor area of greater than 80 $m^2$ have sufficient space to allow the storage of recyclables, therefore only the 1960s-1970s multi-units do not have this available. |
| Outdoor recyclables storage | It is assumed that average homes that have ground level access (all cohorts) will have sufficient space outdoors to allow for the storage of recyclables. |
| Composting facilities? | All homes originally had a compost heap, however newer homes were built with in-sink waste disposers after the 1970s. Information is not available about the number of homes that have composting or worm farm disposal systems for organic waste. The amount of organic waste that is sent to landfill indicates that many homes do not. However the conservative position of "No" must be used in lieu of better information. |
| Enviro choice products used? | EnviroChoice was not available until the 1990s, but it appears to be gaining brand recognition and consequent market share. However in lieu of information on uptake we can only assume the conservative option of "No". |
| Moisture question | The previous parameters are used to assemble the answers to this question. Many of these (11) apply to homes in the earliest cohorts, and only two or three (carpet in entrance/wet areas, recessed lighting and overheating in summer) apply to the latest homes. A linear interpolation has been performed to distribute the parameters between these two setpoints. |
| Safety and security | The HCS reports that 95% of homes have some security measures, with more than 50% now having burglar alarms. Information in Ryan et al (2008) does not suggest such a high uptake, so an interpolation between a minimum of two features in early housing and a maximum number of seven features in recent housing has been made using the information available. |
| Disabled friendly? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Home maintenance manual? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Storm water managed on-site? | 80% of the New Zealand population live in urban areas, and over 90% of urban areas have council operated storm water systems (see www.mfe.govt.nz), so the council option is used for all cohorts. |

| | |
|---|---|
| Native landscaping present? | Insufficient information is available to make a choice here, so the most conservative position of less than 50% must be chosen. |
| Pest plants present? | There is no definition of 'pest plants' provided in the Homestar™ tool. However the Greater Wellington Regional Council lists pest plants that may be present in gardens and green areas, including many plants that are valued in flower gardens. See http://www.gw.govt.nz/assets/Plans--Publications/Wairarapa-Coastal-Strategy/713_caring_for_our_co_s1349.pdf. In lieu of better information the conservative option of "Yes" must be chosen. |
| Veggie garden of >3 $m^2$? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Food trees – two or more? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Location walkable within 10 min? | Ryan et al (2008) provide information indicating that earlier cohorts were located in areas where amenities were close by, since walking was the predominant means of travel. As suburbs developed, fewer amenities were located in the area as motorised transport became predominant. Thus, we will linearly interpolate from a maximum walkability of 12 to a minimum of one for the cohorts. |

## 7.3 The Building Act legislative requirements

**Table 5: Building Act, as required by the DBH through the NZBC. Justification of values for parameters for the 52 Homestar™ self-assessment questions for modal homes of 15 typologies according to the legislative obligations of the Building Act**

| Aspect | DBH policy justification |
|---|---|
| Home age | As per typology. |
| Floor area | Same construction, so no change from the "Current State" option. |
| Bedrooms | Same construction, so no change from the "Current State" option. |
| Storeys | Same construction, so no change from the "Current State" option. |
| Space heater (main type used) | Same construction, so no change from the "Current State" option. |
| DHW (main water heater) | Same construction, so no change from the "Current State" option. |
| Cylinder wrapped? | No change from the "Current State" option. |
| Cylinder age | No change from the "Current State" option. |
| DHW pipes insulated? | The NZBC requirements of the time dictates when pipe insulation is used, indicating that no lagging before the 1950s, then first metre lagging after that, as for the "Current State" option. |
| Light bulb types used? | No change from the "Current State" option. |
| Fridges/freezer number? | No change from the "Current State" option. |
| Oldest fridge/freezer age? | No change from the "Current State" option. |
| Renewable generation on-site? | No change from the "Current State" option. |
| Window size | Same construction, so no change from the "Current State" option. |
| Window orientation | Same construction, so no change from the "Current State" option. |
| Solar access | Same construction, so no change from the "Current State" option. |
| Window type | Same construction, so no change from the "Current State" option. |
| Curtains (thick on all windows?) | Same construction, so no change from the "Current State" option. |
| Ceiling insulation (how much?) | The assumption is made that no change has been made to the insulation levels from construction since this represents the condition of the home typology under the NZBC requirements of the time. Thus, the insulation values differ from the "Current State" typologies here. |
| Problems in insulation | No defects are allowed, since it is assumed that the NZBC level of insulation applicable at the time has been installed, and maintained at this level. This is irrespective of information which suggests that this level was not achieved – this is an assessment of the implication of NZBC level achievement, not a representation of reality. |

| | |
|---|---|
| Recessed lights (number present?) | Recessed lights have never been required under the NZBC, and are not necessarily included in a ceiling replacement since construction. Since they reduce performance of the building envelope, they are not included in any typology. |
| Wall construction type | Same construction, so no change from the “Current State” option. |
| Wall insulation present? | As for the ceiling insulation, the code applicable at the time has been used to determine the Homestar™ inputs. |
| Thermal mass – are walls exposed to sun and heavy? | Same construction, so no change from the “Current State” option. |
| Air-loose window | The windows are assumed to comply with the NZBC applicable at the time, and to be maintained in this state, unless they have been replaced out of necessity. No excessive air leakage is assumed. |
| Timber doors | As for windows. |
| Strip floors | Same construction, so no change from the “Current State” option. |
| Open fire | Same construction, so no change from the “Current State” option. |
| Draughts – is draughty construction used? | As for windows, it is assumed that the original airtightness of joinery has been maintained, and that this is sufficient. |
| Floor material | Same construction, so no change from the “Current State” option. |
| Concrete insulation | Same construction, so no change from the “Current State” option. |
| Timber insulation | As for the ceiling insulation, the NZBC applicable at the time has been used to determine the Homestar™ inputs for floor insulation. |
| Foil insulation problems | Assume concrete floors, so no foil. |
| Bulk insulation problems | Assume concrete floors, so no bulk insulation. |
| Complete coverage? | No insulation used, so no complete coverage possible. |
| Solar access to the floor | Same construction, so no change from the “Current State” option. |
| Underfloor damp? | No – the assumption is made that wet sites are not used, and that sound construction practice to the NZBC would not allow for damp underfloor conditions to establish. |
| Vented rangehood? | The NZBC ventilation and moisture requirements do not require rangehoods since operable windows are sufficient. |
| Vented bathrooms? | The NZBC ventilation and moisture requirements do not require extract fans since operable windows are sufficient. |
| Outdoor covered washing line? | Same construction, so no change from the “Current State” option. |

| | |
|---|---|
| Rain water tank? | Same construction, so no change from the "Current State" option. |
| Shower flow rate max | Shower heads may have worn out, and been replaced since construction of the building, so the "Current State" values are used. |
| Toilet flush volume | Toilet cisterns may have worn out, and been replaced since construction of the building, so the "Current State" values are used. |
| WELS dishwasher | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| WELS clothes washer | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Grey water system present? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Recyclable storage inside? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Outdoor recyclables storage | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Composting facilities? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Enviro choice products used? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Moisture question | A rating of up to two has been subtracted from the "Current State" rating given the lack of damp underfloor and downlights. |
| Safety and security | Same construction, so no change from the "Current State" option. |
| Disabled friendly? | Same construction, so no change from the "Current State" option, except from the late 1990s when the NZBC began to require accessible features. |
| Home maintenance manual? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Storm water managed on-site? | Same construction, so no change from the "Current State" option. |
| Native landscaping present? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Pest plants present? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Veggie garden of >3 $m^2$? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Food trees – two or more? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |
| Location walkable within 10 min? | Not relevant to the DBH policy implementation, so the "Current State" values are used. |

## 7.4 The Waste Minimisation Act legislative requirements

**Table 6: Waste Minimisation Act – justification of values for parameters for the 52 Homestar™ self-assessment questions for modal homes of 15 typologies according to the legislative obligations of the WMA**

| Aspect | WMA policy justification |
|---|---|
| Home age | As per typology. |
| Floor area | Not in the scope of the WMA, so no change from the "Current State" option. |
| Bedrooms | Not in the scope of the WMA, so no change from the "Current State" option. |
| Storeys | Not in the scope of the WMA, so no change from the "Current State" option. |
| Space heater (main type used) | Not in the scope of the WMA, so no change from the "Current State" option. |
| DHW (main water heater) | Not in the scope of the WMA, so no change from the "Current State" option. |
| Cylinder wrapped? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Cylinder age | Not in the scope of the WMA, so no change from the "Current State" option. |
| DHW pipes insulated? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Light bulb types used? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Fridges/freezer number? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Oldest fridge/freezer age? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Renewable generation on-site? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Window size | Not in the scope of the WMA, so no change from the "Current State" option. |
| Window orientation | Not in the scope of the WMA, so no change from the "Current State" option. |
| Solar access | Not in the scope of the WMA, so no change from the "Current State" option. |
| Window type | Not in the scope of the WMA, so no change from the "Current State" option. |
| Curtains (thick on all windows?) | Not in the scope of the WMA, so no change from the "Current State" option. |
| Ceiling insulation (how much?) | Not in the scope of the WMA, so no change from the "Current State" option. |
| Problems in insulation | Not in the scope of the WMA, so no change from the "Current State" option. |
| Recessed lights (number present?) | Not in the scope of the WMA, so no change from the "Current State" option. |

| | |
|---|---|
| Wall construction type | Not in the scope of the WMA, so no change from the “Current State” option. |
| Wall insulation present? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Thermal mass – are walls exposed to sun and heavy? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Air-loose window | Not in the scope of the WMA, so no change from the “Current State” option. |
| Timber doors | Not in the scope of the WMA, so no change from the “Current State” option. |
| Strip floors | Not in the scope of the WMA, so no change from the “Current State” option. |
| Open fire | Not in the scope of the WMA, so no change from the “Current State” option. |
| Draughts – is draughty construction used? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Floor material | Not in the scope of the WMA, so no change from the “Current State” option. |
| Concrete insulation | Not in the scope of the WMA, so no change from the “Current State” option. |
| Timber insulation | Not in the scope of the WMA, so no change from the “Current State” option. |
| Foil insulation problems | Not in the scope of the WMA, so no change from the “Current State” option. |
| Bulk insulation problems | Not in the scope of the WMA, so no change from the “Current State” option. |
| Complete coverage? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Solar access to the floor | Not in the scope of the WMA, so no change from the “Current State” option. |
| Underfloor damp? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Vented rangehood? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Vented bathrooms? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Outdoor covered washing line? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Rain water tank? | Not in the scope of the WMA, so no change from the “Current State” option. |
| Shower flow rate max | Not in the scope of the WMA, so no change from the “Current State” option. |

| | |
|---|---|
| Toilet flush volume | Not in the scope of the WMA, so no change from the "Current State" option. |
| WELS dishwasher | Not in the scope of the WMA, so no change from the "Current State" option. |
| WELS clothes washer | Not in the scope of the WMA, so no change from the "Current State" option. |
| Grey water system present? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Recyclable storage inside? | MfE policy is to "minimise waste" which we interpret to mean recyclable materials are stored to minimise solid waste collection requirements. |
| Outdoor recyclables storage | MfE policy is to "minimise waste" which we interpret to mean recyclable materials are stored to minimise solid waste collection requirements. |
| Composting facilities? | MfE policy is to "minimise waste" which we interpret to mean that a composting facility is used to minimise the volume of solid organic waste sent to council land/cleanfills. |
| Enviro choice products used? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Moisture question | Not in the scope of the WMA, so no change from the "Current State" option. |
| Safety and security | Not in the scope of the WMA, so no change from the "Current State" option. |
| Disabled friendly? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Home maintenance manual? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Storm water managed on-site? | MfE policy is to "minimise waste" which we interpret to mean that storm water is dealt with on-site in order to minimise the flow of storm water to the reticulated stormwater system. |
| Native landscaping present? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Pest plants present? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Veggie garden of >3 $m^2$? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Food trees – two or more? | Not in the scope of the WMA, so no change from the "Current State" option. |
| Location walkable within 10 min? | Not in the scope of the WMA, so no change from the "Current State" option. |

## 7.5 EECA policy ratings – justification

**Table 7: EECA – justification of values for parameters for the 52 Homestar™ self-assessment' questions for the optimal EECA policy implementation**

| Aspect | EECA policy justifications |
|---|---|
| Home age | As per typology. |
| Floor area | No change from the "Current State" option. |
| Bedrooms | No change from the "Current State" option. |
| Storeys | No change from the "Current State" option. |
| Space heater (main type used) | EECA policy requires efficient clean technologies for space heating, and that homes be "warm and dry". Thus the living space must be heated, not just one room, so we need a ducted heat pump as the most effective cleanest technology available in the Homestar™ tool to achieve these goals. |
| DHW (main water heater) | EECA policy requires efficient clean technologies for water heating. Thus we need a solar water heater with electric boost as the most effective and cleanest technology to achieve these goals. The assumptions are that: gas is not as clean as electricity provided: the renewable fraction stays above about 60% in electricity; the renewable fraction of solar hot water is over 50%; and clean burning wetback systems (pellet and biomass fires) are not common and are not the most suitable space heating devices so are only installed as water heaters. So we choose the solar water heater electric boost as the best appliance available in the Homestar™ tool to achieve the EECA policy goals with these assumptions. AS/NZS4013 'Domestic solid fuel burning appliances – method for determination of flue gas emission'. |
| Cylinder wrapped? | Wrapping of the cylinder is not appropriate since we are choosing an A-rated cylinder manufactured after 2004 for all cohorts. |
| Cylinder age | Post-2004 cylinders are all A-rated insulation cylinders so there will be little cost benefit from additional insulation. |
| DHW pipes insulated? | Efficiency may be improved by insulating pipes (HEEP, 2004), so by default all pipes are fully insulated. |
| Light bulb types used? | EECA do not have a policy to encourage users away from standard lighting, although some of their programmes are doing this, particularly now that the residential energy efficiency team from the Electricity Commission has been incorporated into the EECA. Hence no change from "Today" policy. |
| Fridge/freezer numbers? | While EECA do have a MEPS for refrigeration there is no EECA policy about requiring certain performance in homes, only one about the sale of new products. Hence homeowners can move in their old fridge/freezers, and no change is necessary from the "Today" rating. |
| Oldest fridge/freezer age? | No change from the "Current State" option (see also the justification for the number of fridge/freezers.) |
| Renewable generation on-site? | EECA policy is that "the costs of distributed generation technologies have reduced to a level that is commonly affordable". My interpretation therefore is that between 25% and 50% of the electrical energy requirements are provided from site generation. |
| Window size | EECA do not have a policy that includes the changing of the external cladding or windows, so there is no change to this specification from the "Current State" rating. |
| Window orientation | No change from "Current State" since EECA have no policy regarding changing the window orientation. |

| | |
|---|---|
| Solar access | No change from "Current State". |
| Window type | The window frame material must to kept to maintain the typology and any potential 'Heritage' value of windows in all cohorts. However standard clear double-glazed IGUs can be installed in all window frames to improve the thermal performance, and comply with the EECA policy that "New Zealanders live in homes that are warm and dry". Thus all glazing is upgraded to IGU, with the same frame material used. |
| Curtains (thick on all windows?) | To comply with the EECA policy that "New Zealanders live in homes that are warm and dry", all the windows are rated as having thick curtaining. |
| Ceiling insulation (how much?) | This is the maximum level of the 2008 NZS4218 Code for NZS4218 climate zones 1, 2 and 3 – effectively two layers of 70-100 mm insulation providing between R-2.9 and R-3.3. Since the EECA is a government department their policy cannot exceed that of the DBH for new home insulation. The DBH has used cost benefit analysis to recommend the best insulation levels for insulation codes, which must also be true for EECA policy, except in particular (non-average) situations. Since we need the average situation, and need to achieve homes that are "warm and dry", we will apply the maximum 2008 DBH H1 Code levels of R-2.9 and R-3.3. |
| Problems in insulation | The assumption is made that the EECA policy works and that all non-compliances with insulation installation requirements are eliminated, so no defects are present to reduce the thermal effect of the ceiling insulation. |
| Recessed lights (number present?) | Work for EECA (Burgess et al, 2010) has shown that recessed downlights are not a responsible addition to homes, and marginalise the thermal performance of the ceiling. Since average homes are single storey, the ceilings will be the thermal envelope, and so no downlights can be allowed to penetrate this layer. |
| Wall construction type | No change from the "Current State" option. |
| Wall insulation present? | The tool accesses the answer to the question of home age and assigns the Code level applicable at that time. The "Extra thick" option is for 120 mm studs which allows for R2.1 insulation. Since the NZS4218:2004 Code change lifted the zones 1 and 2 insulation R-value to 1.9, this will be used to meet the EECA Code expectation for all the cohorts. |
| Thermal mass – are walls exposed to sun and heavy? | The information in the Beacon report (Ryan et al, 2008) indicates that the average internal walls are light timber frame. EECA policy does not require a change to this default expectation. |
| Air-loose window | The EECA policy of "warm and dry" does not allow uncontrolled infiltration, so all windows are assumed to be airtight. |
| Timber doors | The EECA policy of "warm and dry" does not allow uncontrolled infiltration, so all doors are assumed to be airtight, by not allowing timber. |
| Strip floors | The EECA policy of "warm and dry" does not allow uncontrolled infiltration, so all floors are assumed to be airtight, by not selecting strip timber floors. |
| Open fire | The EECA policy of "warm and dry" does not allow uncontrolled infiltration, so open fires are deemed to not be available. |
| Draughts – is draughty construction used? | The EECA policy of "warm and dry" does not allow uncontrolled infiltration, so draughty construction is not assumed. |
| Floor material | The information in Ryan et al (2008) indicates that the average flooring type for this era/cohort is timber for the "Current State" rating, so this is used for EECA policy rating as well. |

| | |
|---|---|
| Concrete insulation | Enactment of EECA policy cannot exceed the DBH Code level, being R-1.3 for all concrete floors of average length/width proportions, so no insulation can be added to the default situation. |
| Timber insulation | Enactment of EECA policy cannot exceed the DBH Code level, being R-1.3 for all timber floors with foil, so all timber floors are assumed to have foil. |
| Foil insulation problems | No problems are allowed since we are applying EECA policy. |
| Bulk insulation problems | No problems are allowed since we are applying EECA policy. |
| Complete coverage? | Complete coverage is assumed since we are applying EECA policy. |
| Solar access to the floor | EECA policy does not implement any change from "Current State". |
| Underfloor damp? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry" we cannot have damp subfloors, so use polythene to convert damp to dry. |
| Vented rangehood? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we must have vented rangehoods. |
| Vented bathrooms? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we must have vented bathrooms |
| Outdoor covered washing line? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we cannot have any washing being dried inside, thus all homes must have outdoor covered washing lines. |
| Rain water tank? | This is irrelevant to EECA policy, so we use the same rating as for the "Current State" parameterisation. |
| Shower flow rate max | Irrelevant to EECA policy. Efficiency of generation is relevant, but not the usage. Must stay as "Current State". |
| Toilet flush volume | Irrelevant to EECA policy. Must stay as "Current State". |
| WELS dishwasher | While EECA have implemented the mandatory labelling of dishwashers (AS/NZS 2007.2:2005) there is no MEPS in place to date. Hence no change is necessary from the "Today" rating, which uses three stars. |
| WELS clothes washer | While the EECA has implemented the mandatory labelling of clothes washers (AS/NZS 2040.1 and .2:2005) there is no MEPS in place to date. Hence no change is necessary from the "Today'" rating, which uses three stars. |
| Grey water system present? | Not relevant to EECA policy, so use the parameter value from the "Current State" rating. |
| Recyclable storage inside? | Not relevant to EECA policy, so use the parameter value from the "Current State" rating. |
| Outdoor recyclables storage | Not relevant to EECA policy, so use the parameter value from the "Current State" rating. |
| Composting facilities? | Not relevant to EECA policy, so use the parameter value from the "Current State" rating. |
| Enviro choice products used? | Not relevant to EECA policy, so use the parameter value from the "Current State" rating. |
| Moisture question | Abestos is the only non-moisture issue here that gives a rating from the housing through to the early 1980s. The EECA has no overheating policy, so we assume that all homes may overheat in summer. |
| Safety and security | Not relevant to EECA policy, so use the parameter value from the "Current State" |

| | |
|---|---|
| | rating. |
| Disabled friendly? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Home maintenance manual? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Stormwater managed on-site? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Native landscaping present? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Pest plants present? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Veggie garden of >3 $m^2$? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Food trees – two or more? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |
| Location walkable within 10 min? | Not relevant to EECA policy, so use the parameter value from the “Current State” rating. |

## 7.6 'Combined policy' ratings –justification

**Table 8: Combination – justification of values for parameters for the 52 Homestar™ self-assessment questions for the most favourable policy implementations from the three central government agencies (MfE, DBH, EECA)**

| Aspect | Combined policy justification |
|---|---|
| Home age | As per typology. |
| Floor area | Same construction, so no change from the "Current State" option. |
| Bedrooms | Same construction, so no change from the "Current State" option. |
| Storeys | Same construction, so no change from the "Current State" option. |
| Space heater (main type used) | EECA policy requires efficient clean technologies for space heating, and that homes be "warm and dry". Thus the living space must be heated, not just one room, so we need a ducted heat pump as the most effective cleanest technology available in the Homestar™ tool to achieve these goals. |
| DHW (main water heater) | EECA policy requires efficient clean technologies for water heating. Thus we need a solar water heater with electric boost as the most effective cleanest technology to achieve these goals. The assumptions are that: gas is not as clean as electricity provided the renewable fraction stays above about 60% in electricity; the renewable fraction of solar hot water is over 50%; clean burning wetback systems (pellet and biomass fires) are not common and are not the most suitable space heating devices so are only installed as water heaters. So we choose the solar water heater electric boost as the best appliance available in the Homestar™ tool to achieve the EECA policy goals with these assumptions. AS/NZS4013 'Domestic solid fuel burning appliances – method for determination of flue gas emission'. |
| Cylinder wrapped? | Wrapping of the cylinder is not appropriate since we are choosing an A-rated cylinder manufactured after 2004 for all cohorts. |
| Cylinder age | Post-2004 cylinders are all A-rated insulation cylinders so there will be little cost benefit from additional insulation. |
| DHW pipes insulated? | Efficiency may be improved by insulating pipes (HEEP, 2004), so by default all pipes are fully insulated. |
| Light bulb types used? | None of the agencies had policy in this area a the time of investigation, so no change from "Today" policy |
| Fridges/freezer number? | No change from the "Current State" option. |
| Oldest fridge/freezer age? | No change from the "Current State" option. |
| Renewable generation on-site? | No change from the "Current State" option. |
| Window size | No change from the "Current State" option. |
| Window orientation | No change from the "Current State" option. |
| Solar access | No change from the "Current State" option. |

| | |
|---|---|
| Window type | No change from the “Current State” option. |
| Curtains (thick on all windows?) | To comply with the EECA policy that “New Zealanders live in homes that are warm and dry”, all the windows are rated as having thick curtaining. |
| Ceiling insulation (how much?) | EECA – this is the maximum level of the 2008 NZS4218 Code for NZS4218 climate zones 1, 2 and 3 – effectively two layers of 70-100 mm insulation providing between R-2.9 and R-3.3. Since the EECA is a government department their policy cannot exceed that of the DBH for new home insulation. The DBH has used cost benefit analysis to recommend the best insulation levels for insulation codes, which must also be true for EECA policy, except in particular (non-average) situations. Since we need the average situation, and need to achieve homes that are “warm and dry”, we will apply the maximum 2008 DBH H1 Code levels of R-2.9 and R-3.3. |
| Problems in insulation | The assumption is made that the EECA policy works and that all non-compliances with insulation installation requirements are eliminated, so no defects are present to reduce the thermal effect of the ceiling insulation. |
| Recessed lights (number present?) | Work for EECA (Burgess et al, 2010) has shown that recessed downlights are not a responsible addition to homes, and marginalise the thermal performance of the ceiling. Since average homes are single storey, the ceilings will be the thermal envelope, and so no downlights can be allowed to penetrate this layer. |
| Wall construction type | Same construction, so no change from the “Current State” option. |
| Wall insulation present? | EECA – the tool accesses the answer to the question of home age and assigns the Code level applicable at that time. The “Extra thick” option is for 120 mm studs which allows for R2.1 insulation. Since the NZS4218:2004 Code change lifted the zone 1 and 2 insulation R-value to 1.9, this will be used to meet the EECA Code expectation for all the cohorts. |
| Thermal mass – are walls exposed to sun and heavy? | The information in the Beacon report (Ryan et al, 2008) indicates that the average internal walls are light timber frame. Combined policy does not require a change to this default expectation. |
| Air-loose window | The EECA policy of “warm and dry” does not allow uncontrolled infiltration, so all windows are assumed to be airtight. |
| Timber doors | As for windows. |
| Strip floors | The EECA policy of “warm and dry” does not allow uncontrolled infiltration, so all floors are assumed to be airtight by not selecting strip timber floors. |
| Open fire | The EECA policy of “warm and dry” does not allow uncontrolled infiltration, so open fires are deemed to not be available. |
| Draughts – is draughty construction used? | The EECA policy of “warm and dry” does not allow uncontrolled infiltration, so draughty construction is not assumed. |
| Floor material | The information in Ryan et al (2008) indicates that the average flooring type for this era/cohort is timber for the “Current State” rating, so this is used for EECA policy rating as well. |

| | |
|---|---|
| Concrete insulation | Enactment of EECA policy cannot exceed the DBH Code level, being R-1.3 for all concrete floors of average length/width proportions, so no insulation can be added to the default situation. |
| Timber insulation | Enactment of EECA policy cannot exceed the DBH Code level, being R-1.3 for all timber floors with foil, so all timber floors are assumed to have foil. |
| Foil insulation problems | No problems are allowed since we are applying EECA policy, and assuming that this level is maintained. |
| Bulk insulation problems | No problems are allowed since we are applying EECA policy, and assuming that this level is maintained. |
| Complete coverage? | No insulation used, so no complete coverage possible. |
| Solar access to the floor | Same construction, so no change from the "Current State" option. |
| Underfloor damp? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we cannot have damp subfloors, so use polythene to convert damp to dry. |
| Vented rangehood? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we must have vented rangehoods. |
| Vented bathrooms? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we must have vented bathrooms |
| Outdoor covered washing line? | Since EECA policy is to have all "New Zealanders live in homes that are warm and dry", we cannot have any washing being dried inside, thus so all homes must have outdoor covered washing lines. |
| Rain water tank? | Same construction, so no change from the "Current State" option. |
| Shower flow rate max | MfE policy is to "minimise waste" which we interpret to mean that an efficient shower head is used to minimise the flow of waste water to the sewage system. |
| Toilet flush volume | MfE policy is to "minimise waste" which we interpret to mean that a low-flush volume toilet cistern is used to minimise the flow of waste water to the sewage system. |
| WELS dishwasher | MfE policy is to "minimise waste" which we interpret to mean that a low-water-use dishwasher (six star) is used to minimise the flow of waste water to the sewage system. |
| WELS clothes washer | MfE policy is to "minimise waste" which we interpret to mean that a low-water-use clothes washer (six star) is used to minimise the flow of waste water to the sewage system. |
| Grey water system present? | MfE policy is to "minimise waste" which we interpret to mean that a grey water system is used to minimise the flow of waste water to the sewage system. |
| Recyclable storage inside? | It is assumed that average homes with a floor area of greater than 80 $m^2$ have sufficient space to allow the storage of recyclables, therefore only the 1960s-1970s multi-units do not have this available. |
| Outdoor recyclables storage | Not relevant to the DBH policy implementation, so the "Current State" values are used. |

| | |
|---|---|
| Composting facilities? | MfE policy is to "minimise waste" which we interpret to mean that a composting facility is used to minimise the volume of solid organic waste sent to council land/cleanfills. |
| Enviro choice products used? | EnviroChoice was not available until the 1990s, although it appears to be gaining brand recognition and consequent market share. However in lieu of information on uptake we can only assume the conservative option of "No". |
| Moisture question | A rating of up to two has been subtracted from the "Current State" rating given the lack of damp underfloor and downlights. |
| Safety and security | The HCS reports that 95% of homes have some security measures, with more than 50% now having burglar alarms. Information in Ryan et al (2008) does not suggest such a high uptake, so an interpolation between a minimum of two features in early housing and seven features in recent housing has been made using the information available. |
| Disabled friendly? | Same construction, so no change from the "Current State" option, except from the late 1990s when the Code began to require accessible features. |
| Home maintenance manual? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Stormwater managed on-site? | MfE policy is to "minimise waste" which we interpret to mean that storm water is dealt with on-site in order to minimise the flow of storm water to the reticulated storm water system. |
| Native landscaping present? | Insufficient information is available to make a choice here, so the most conservative position of less than 50% must be chosen. |
| Pest plants present? | There is no definition of 'pest plants' provided in the Homestar™ tool. However the Greater Wellington Regional Council lists pest plants that may be present in gardens and green areas, including many plants that are valued in flower gardens. See http://www.gw.govt.nz/assets/Plans--Publications/Wairarapa-Coastal-Strategy/713_caring_for_our_co_s1349.pdf. In lieu of better information the conservative option of "Yes" must be chosen, except for the latest housing where pest plants have not been introduced or invaded. |
| Veggie garden of >3 $m^2$? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Food trees – two or more? | Insufficient information is available to make a choice here, so the most conservative position of "No" must be chosen. |
| Location walkable within 10 min? | Not relevant to agency policy implementation so the "Current State" values are used. |

## 7.7 Appendix – Government agency policy pro-formas

Not all of the information gathered from interviews was relevant to this work, and not all of it could be approved, so these remain my interpretation of the view of the agency.

### 7.7.1 Department of Building and Housing

*Status, authority*
Lead policy agency for residential housing in New Zealand.
*Date information obtained*
March-April 2010.
*Contacts/source of information*
Adrian Bennett, Nick Locke, John Harcourt, DBH website (www.dbh.govt.nz).
*Influencers of agency policy*
International activity, government policy driving productivity, health and comfort, not currently focussed on environmental issues.
*Sphere of influence of agency policy (new/existing, sectors)*
National, through the Building Act, and then through the NZBC which is implemented through councils. Principally relevant to new build, although some legislation covers existing housing when interventions are being made and the need for a building consent is triggered. Smarter Homes is their flagship programme.
*Environmental/sustainability policy*

- *Solid waste*

The Building Code addresses waste through Clause G15 'Solid waste', but this is not relevant to stand-alone homes. It is relevant only where homes do not have accessible outside space to store solid waste.

- *Envelope insulation*

Set minimum standards for envelope insulation of new homes to achieve levels of heath and comfort through Clause H1.3.1 of the NZBC referencing NZS4218. Levels will potentially increase over time.

- *Space heating*

The NZBC Clause H1 allows for space heating to be provided, but does not have any mandatory requirements for space heating, except for child and aged-care facilities. There is mention of the WHO recommendation of 18°C being used as a target for living spaces, but this is not policy.
*Water*

- *Water heating*

The NZBC Clause XX requires that a means to heat and supply heated water be provided in all residential construction under H1.3.4, with a minimum performance standard required under NZS4305.

- *Potable water*

The NZBC requires potable water to be supplied to a residence under G12.3, but does not have a limitation on volume. Charges for potable water are set by councils as a part of rates or as a separate levy and are not under the control of central government

- *Storm water*

The NZBC provides for storm water to be managed under Clause E1.3.3 'Surface water', where storm water with a certain likelihood of occurring annually must be controlled and not

enter buildings. Although there is no requirement for the storage and use of storm water, it is allowed by the NZBC.

- *Foul water*

The NZBC Clause G13 'Foul water' requires that a service be provided to remove foul water or black water (sewage) from a residence, but no discrimination is made between black and grey water.

*Materials*

The NZBC addresses the use of materials to prevent adverse affects on health and amenity from the like of chemically treated timber under NZS3602. The durability of materials is addressed under Clause B2.3.1 'Durability' where there is a lifetime expectation for all materials used, ranging from 5-50 years. Volume, Life Cycle Costing (LCC) or sustainable sourcing of materials is of no concern to DBH policy, except for hazardous materials.

*IEQ*

The NZBC covers IEQ under Clauses E3.3 'Moisture', G4.3 'Ventilation', G6.3 'Airborne and impact sound', G7.3 'Natural light' and G8.3 'Artificial light'. These clauses provide for adequate ventilation, lighting and acoustic environments.

*Context*

The DBH is the lead agency for developing policy about the new built environment, however it does not currently have a mandate to improve the sustainability of this environment. Policy regarding the new and existing housing stock is contained with the Smarter Homes website (www.smarterhomes.org.nz).

### 7.7.2 Ministry of Civil Defence and Emergency Management

*Status, authority*

Part of the Department of Internal affairs. Operates under the Civil Defence Act, under which sits the natinoal civil defince strategy document, then national planning, then regional and council plans. They are a strong policy agency who have responsibility for the management of natural hazards as events that impinge upon the housing stock.

*Date information obtained*

March- April 2010.

*Contacts/source of information*

Jonathon Jull, Peter Wood.

*Influencers of agency policy*

DBH.

*Sphere of influence of agency policy (new/existing, sectors)*

National, new and existing construction. MCDEM put together frameworks, and operate as advocates and facilitators to assist other government departments.

*Environmental/sustainability policy*

- *Waste*

Not relevant to MCDEM.

- *Envelope insulation*

Not relevant.

- *Space heating*

Not relevant, except in terms of the danger to the public of disturbed or damaged supply infrastructure of electricity and gas.

*Water*

- *Water heating*

Relevant in terms of resilience to natural hazards, and ability to restore service quickly following a natural disaster. Restraining of storage water tanks for earthquake resilience is key.

- *Potable water*

Relevant in terms of resilience to natural hazards, and ability to restore service quickly following a natural disaster.

- *Storm water*

Not relevant, except in terms of the danger to the public of disturbed or damaged infrastructure for storm water.

- *Black water*

Relevant in terms of resilience to natural hazards, and ability to restore infrastructure quickly following a natural disaster.

*Materials*

Relevant in terms of resilience to natural hazards, contribution to free debris following hazard events, or toxicity.

*IEQ*

Not relevant.

*Context*

A resilient New Zealand is desired. The current NZBC has very little involvement in natural hazard implications. The revision of the NZBC that was proposed under the previous Labour government in 2004 had significant consideration of natural hazards, but was shelved.

Their interest in sustainability stems from the need to quickly restore function to the housing stock, and to encourage the use of materials, constructions and devices that are readily restored.

### 7.7.3 Housing Corporation of New Zealand

*Status, authority*

Crown Entity, operates under Housing Corporation Act, has a responsibility to prudentially manage the housing stock owned by the Crown, sits under the Housing Minister, Phil Heatley. The DBH has a monitoring role over the corporation and report to their minister (currently also Heatley).

*Date information obtained*

15 -21 April 2010.

*Contacts/source of information*

Gill Palmer, Guy Penny, Christine Cheong.

*Influencers of agency policy*

DBH, EECA.

*Sphere of influence of agency policy (new/existing, sectors)*

New and existing homes – principally the 69,000 homes in their portfolio. May also influence private landlords. Their flagship has been 'The New Zealand Housing Strategy: Building the Future'. However this document was developed under the previous administration and no longer contains the current policy.

*Environmental/sustainability policy*

- *Waste*

See *Materials* – no policy regarding the operation of the home by the tenants is appropriate here.

- *Envelope insulation*

Concern that the H1 Code (NZS4218 levels) does not allow them to install higher levels of insulation where this may be beneficial.

- *Space heating*

Do not necessarily have the same cost benefit approach to the use of envelope insulation as the EECA, since many tenants may suffer fuel poverty, and thus only have a fixed amount of money available for space heating. The relationship between envelope insulation and space heating may have a different cost benefit when lower levels and schedules of heating are used.

*Water*

- *Water heating*

No comment.

- *Potable water*

HCNZ pay the rates bills of properties and also pay the potable water charges where these are separated from the rates. This is an interesting scenario since the other utilities (phone, power, TV, internet) are clearly the responsibility of the tenant, and HCNZ has no instrument available to influence the consumption of potable water other than the installation of low-flow fittings and water tanks.

- *Storm water*

No comment.

- *Black water*

No comment.

*Materials*

Have waste minimisation targets for new build and renovation based on REBRI, where 95% of demolition material has been diverted from landfill, as has 70% of construction waste.

Have internal guidelines on material choice, including procurement arrangements with environmental appraisal requirements developed by the HCNZ for issues including material toxicity, to assist in the selection of materials. Asset managers have a schedule of acceptable products that includes a product score, and input from history of use. Environmental Choice rated products can be used as part of this.

*IEQ*

Believe that air infiltration is a significant issue for particularly the older stock, where the health of the occupants is significantly affected.

*Context:*

The HCNZ is a Crown entity, which is maintained at 'arms length' from central government, and is driven by the Housing Corporation Act. The HCNZ has policy functions, particularly with the housing assistance policy which assists low-income tenants into housing. The DBH makes regulatory policy, and governs the Residential Tenancies Act. The HCNZ is the largest landlord in New Zealand with over 66 000 homes. They developed 'The New Zealand Housing Strategy: Building the Future' under the Labour-led government, but this is under review. The HCNZ has a number of internal policy documents that inform their work, driven by annual outcomes required by their charter, CEO or minister.

### 7.7.4 Ministry for the Environment

*Status, authority*

Lead policy agency for environmental issues. Responsible for RMA, WMA, NESs and other Acts involving environmental issues.

*Date information obtained*

March-April 2010.

*Contacts/source of information*

Chris Wood, www.sustainability.govt.nz website.

*Influencers of agency policy*
DBH, EECA.
*Sphere of influence of agency policy (new/existing, sectors)*
National. Their flagship is the sustainability website and the NZWS (Waste Strategy)
*Environmental/sustainability policy*

- *Waste*

Through the WMA seek to reduce, reuse and recycle. They have used the REBRI guidelines, although these are now encapsulated in the sustainability website content.

- *Envelope insulation*

Not within jurisdiction, however refer to sustainability website and Smarter Homes programme.

- *Space heating*

Not specifically within jurisdiction, however have an interest in reduction in supply side of electricity. Clean heating, NES, Smarter Homes, and sustainability website policies are relevant.
*Water*

- *sWater heating*

Not specifically within jurisdiction, however have an interest in reduction in supply side of electricity. Systems with low environmental impact are recommended within the sustainability website.

- *Potable water*

Have an interest in reduction in demand and supply through the RMA, which is noted in the sustainability website.

- *Storm water*

Not specifically within the jurisdiction of MfE, however have an interest in impact of the infrastructure, particularly in non-urban areas. No policy issues are mentioned in the sustainability website.

- *Black water*

Not specifically within the jurisdiction of MfE, however have an interest in impact of the treatment infrastructure through the RMA, and is discussed in the sustainability website.
*Materials*
Have recommendations of low environmental impact for materials used under the sustainability website.
*IEQ*
The only IEQ issues that are noted are the recommendations for lighting efficiency from the RightLight website (www.rightlight.govt.nz).
*Context*
Although the MfE has responsibility for environmental impacts of the operation of the housing stock, the housing stock team at EECA was depleted during the compilation of this work, so information was difficult to access. The EECA champions many of the energy-related Sustainability parameters, which has considerable cross over with the role of MfE, but leaves out solid waste, potable water, storm water, foul water, and some of the IEQ parameters such as acoustics and ventilation.

### 7.7.5 The Waste Strategy - NZWS

*Release date: February 2002*
*Key contact(s): Maryanne MacLeod (MfE)*

Reducing waste in this country is a cornerstone of the government's commitment to sustainable development. The New Zealand Waste Strategy (NZWS) (MfE and EECA, 2002) aims to "break the strong link between economic development and waste generation". Up until 2002, waste policies had focused on *end-of-pipe* solutions i.e. dealing with disposal rather than focusing on waste prevention. The NZWS includes core policies such as efficient (waste disposal) pricing and higher environmental standards to better utilise the resources currently wasted.

The NZWS covers solid, liquid and gaseous waste. It also recognises that there is a long-term challenge in the objective of "moving towards zero waste and a sustainable New Zealand".

The NZWS has three core goals, one each directed at the three pillars of sustainability:

- economic: increasing economic benefit by more efficient use of materials
- social: lowering the social cost and risks of waste
- environmental: reducing the damage to the environment from waste generation and disposal.

Organisations, including TAs (see Section 5.5), are able to play a strong role in waste reduction. Obviously this can be directly as *waste generators*, but also indirectly as *designers*, *manufacturers* and *distributors* of the products and services used by the general population.

Three priorities – *waste minimisation*, *hazardous wastes* and *waste disposal* – have been targeted for action in the NZWS. Each of these incorporates detail for specific waste streams and includes specific targets (two key Construction & Demolition (C&D) targets are detailed – refer to MfE 2002 and 2004a for greater detail):

**Priority 1 – Waste minimisation**

- *construction and demolition waste* – make up about 70% (concrete 35%, timber 24%, plasterboard 12%) of the waste stream by weight; presently little financial incentive to reuse or recycle
- by December 2005, all TAs will have instituted a measurement programme to identify existing C&D waste quantities and set local targets for diversion from landfills
- by December 2008, there will have been a reduction of C&D waste to landfills of 50% of December 2005 levels measured by weight.
- *organic wastes* – essentially domestic in origin and includes sewage sludge
- *special wastes* – wastes that need special management e.g. oil, electronics.

**Priority 2 – Hazardous wastes**

- *trade wastes* – generated and disposed from industrial/ manufacturing processes through sewerage system, or to water and land
- *contaminated sites* and *organochlorine compounds.*

**Priority 3 – Waste disposal**

- *waste disposal targets* are being progressively phased in to encourage waste generators to pay the true cost of waste treatment and disposal.

The targets (e.g. for C&D waste) in the NZWS are not yet mandatory. They are national targets and their achievement is significantly dependent on the actions of local authorities. For example, Auckland and Christchurch City Councils have been progressive in putting waste management plans in place which take explicit account of the NZWS.

The targets in the NZWS have been recently reviewed (MfE, 2004a) and have also been adapted for regional contexts (see Section 3). Waste gas emissions (primarily methane) from landfills are also being addressed. The government is proposing the introduction of environmental standards using the RMA (refer to separate discussion below) to control GHG emissions from landfills.

The MfE is currently running its Construction & Demolition Waste Reduction Project. This project aims to provide resources for local and regional authorities, businesses and the community to reduce C&D waste. There are a number of tools being examined:

- development of markets (identifying ways to increase the diversion of waste from landfill)

- recycler verification system (that C & D waste is being transported, handled, reused, recycled or recovered in accordance with industry best practice)
- regulatory tools and best practice guidelines.

### 7.7.6 Department of Conservation

*Status, authority*
Has a Director General who reports to the Minister for Conservation (currently Kate Wilkinson).
*Date information obtained*
17 March 2010.
*Contacts/source of information*
Dave Alcock, Kathryn Maxwell.
*Influencers of agency policy*
DBH, Historic Places Trust (who until 1993 reported to DOC).
*Sphere of influence of agency policy (new/existing, sectors)*
Existing. Their Standard Operating Procedures (SOP) is their flagship.
*Environmental/sustainability policy*

- *Waste*

Duty of care balanced with difficulties of remote sites.

- *Envelope insulation*

NZS4218 when grid connected, but have found that insulation (and heating) has massively improved staff retention.

- *Space heating*

N/A.
*Water*

- *Water heating*

Solar where possible – trialling eight solar water heating systems on ranger homes, with a further 17 at 15 DOC sites.

- *Potable water*

Local procurement where infrastructure is lacking.

- *Storm water*

Local dispersal when storm water reticulation is not available.

- *Black water*

Site treatment where possible.
*Materials*
Driven by their SOP which admits that a duty of care requires the use of low environmental impact materials, although this still includes timber treated with heavy metals.
*IEQ*
Moisture is main issue in isolated locations when teams of 10-12 are assembled for short-term projects.
*Context*
Have 210 homes, 136 serviced huts and 36 Great Walk huts.

### 7.7.7 Energy Efficiency and Conservation Authority (EECA)

*Note the Authority were very cautious about responses to questions about the sustainability of the new and existing housing stock, so much of the content of this report is gleaned from their website rather than from interviews.*

*Status, authority*
Crown Entity, established under the EEC Act 2000. Governed by a Board. Reporting to the Minister of Energy and Resources (currently Gerry Brownlee), and monitored by the MED.
*Date information obtained*
17 March 2010.
*Contacts/source of information*
Alan Davison, Gleb Speranski, www.eeca.govt.nz website.
*Influencers of agency policy*
DBH, MED.
*Sphere of influence of agency policy (new/existing, sectors)*
New, existing, domestic, commercial, industrial. Their flagship is the EnergyWise programme, which contains the other two major programmes of Warm Up New Zealand: Heat Smart, and Rightlight.
*Environmental/Sustainability policy*

- Waste

N/A.

- *Envelope insulation*

DBH – renovation to 2008 Building Code.

- *Space heating*

Warm Up New Zealand, Heat Smart, EnergyWise.
*Water*

- *Water heating*

EnergyWise.

- *Potable water*

N/A.

- *Storm water*

N/A.

- *Black water*

N/A.
*Materials*
N/A.
*IEQ*
RightLight, EnergyWise.

# 8 References


Arundel A, Sterling E, Biggin, J. and Sterling, T., 1986. 'Indirect Health Effects of Relative Humidity in Indoor Environments'. *Environmental Health Perspectives*, 65, 351-361.

Auckland Regional Council, 2003. *Pollution Management - Auckland waste and recycling.* (www.arc.govt.nz/environment/managing-pollution-and-waste/waste-and-recycling/auckland-waste-and-recycling.cfm). Accessed December 2010

Bassett, M.R. 1986 'Building Site Measurements for Predicting Air Infiltration Rates'. In *Measured air Leakage of Buildings*, ASTM STP 904, H. R. Trechsel and P. L. Lagus, Eds., American Society for Testing and Materials, Philadelphia, pp365-383.

Buckett, N.R. and Burgess, J.C. 2007. 'HERS Homeplans'. BRANZ report EC1390/4 for EECA. BRANZ Ltd, Judgeford, New Zealand.

Building and Construction Authority, *Environmental Sustainability Code Singapore, April 2008,* (www.bca.gov.sg/EnvSusLegislation/others/Env_Sus_Code.pdf). Accessed December 2010).

Burgess, J.C., 2008. 'ANZHERS Hot Water Rating Tool'. BRANZ report EC1322 for EECA. BRANZ Ltd, Judgeford, New Zealand.

Burgess, J.C., and Camilleri, M.T., 2010., 'The Home Lighting Survey', BRANZ Report EC1505B for the Electricity Commission, BRANZ Ltd, Judgeford, New Zealand.

Burgess, J.C. (Ed), Buckett, N.R., Camilleri, M.J.T., French, L.J., Pollard, A.R. & Hancock, P.J., 2008. 'Final Monitoring Report from the Papakowhai Renovation Project'. BRANZ report TE106/15 for Beacon Pathway Limited. BRANZ Ltd, Judgeford, New Zealand.

Burrough, L. 2010. 'Heat pumps in New Zealand homes', *Proceedings of the Australasian Housing Researchers Conference.* In press, Auckland, November 2010.

Clark, S.J., Jones, M. & Page, I.C. 2005. 'New Zealand House Condition Survey', BRANZ Report, BRANZ Ltd, Judgeford, New Zealand.

Cunningham, M., Roberts, P. and Hearfield, M., 2001. 'Changes in Indoor Climate and Microclimates of a New Zealand Bungalow after a Two-Stage Insulation Retrofit'. *Proceedings for the CIB World Building Congress.* 8-11 April 2001, Wellington, New Zealand.

Department of Building and Housing, (DBH, 2004), 'The Building Act'. (www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html) Accessed December 2010.

Department of Building and Housing (DBH 2008), 'Statement of Intent, 2010-2013', (www.dbh.govt.nz/UserFiles/File/Publications/Sector/statutory-reports/soi-2010-2013.pdf )

Department of Building and Housing (DBH, 2011). 'The Building Code Approved Documents' (www.dbh.govt.nz/building-code-compliance-documents-downloads) Accessed December 2010

Easton, L., and Howell, M., 2008. 'A High Standard of Sustainability for New Zealand Homes'. *Proceedings of the World Sustainable Building Conference*: *SB08*, 21-25 September 2008. Melbourne, Australia.

Energy Efficiency and Conservation Authority (EECA, 2007) *New Zealand Energy Efficiency and Conservation Strategy, Making it Happen, October 2007*. (www.eeca.govt.nz/sites/all/files/nzeecs-07.pdf) accessed December 2010

Energy Efficiency and Conservation Authority (EECA, 2010) *Statement of Intent 2010–2013* (www.eeca.govt.nz/sites/all/files/statement-of-intent-2010_0.pdf accessed December 2010).

Energy Efficient Strategies, 2008. 'Energy Use in the Australian Residential Sector 1986 – 2020', Prepared for the Department of the Environment, Water, Heritage and the Arts, 2008.

Energy Savings Trust, UK., 2010, *Code for Sustainable Homes*, (www.energysavingtrust.org.uk/Publication-Download/?p=2&pid=1047) Accessed December 2010

Greater Wellington Regional Council (GWRC) *Water use*. www.gw.govt.nz/water-use-3/ accessed December 2010

Green Building Council of Australia (GBCA), 2008. *Green Star Rating Tool.* (www.gbca.org.au/green-star/rating-tools/green-star-multi-unit-residential-v1/1930.htm accessed November 2010).

Green Building Council of Australia (GBCA), 2009. Greenstar Multi-residential rating tool. (www.gbca.org.au/green-star/rating-tools/green-star-multi-unit-residential-v1/1930.htm accessed October 2010).

Heinrich, M. 'Water end-use and efficiency project (WEEP) – a case study'. *Proceedings of the Sustainability of Buildings conference (SB07),* 14-16 November 2007, Auckland , New Zealand.

Housing Corporation of New Zealand (HCNZ, 2006). *Building the Future, the New Zealand Housing Strategy*. (www.hnzc.co.nz/utils/downloads/380D2C40C069A4CE4665F55A8C4523D1.pdf accessed August 2010)

Isaacs, N., Amitrano, L., Camilleri, M., Pollard, A. and Stoecklein, A., 2003. 'Energy Use in New Zealand Homeholds. Report on the Year 7 Analysis for the Homehold Energy End-Use Project (HEEP)'. BRANZ Ltd, Judgeford, New Zealand.

Isaacs, N.P., Camilleri, M., French, L., Pollard, A., Saville-Smith, K., Fraser, R., Rossouw, P. and Jowett, J, 2006. 'Energy Use in New Zealand Homeholds: Report on the Year 10 Analysis for the Homehold Energy End-Use Project (HEEP)'. *BRANZ Study Report 155*. BRANZ Ltd, Judgeford, New Zealand.

Isaacs, N.P., (Ed), Camilleri, M.T., French, L.J., Pollard, A.R., Saville-Smith, K., Fraser, R., Rossouw, P. & Jowett, J., 2010. 'Energy Use in New Zealand Homeholds: Final Report on the Homehold Energy End-Use Project (HEEP)'. *BRANZ Study Report 221*. BRANZ Ltd, Judgeford, New Zealand.

Jaques, R.A., 2004. 'Review of the BRANZ Green Homes Tool', *BRANZ Study report 134*, BRANZ Ltd, Judgeford, New Zealand

Lloyd, B., & Callau, M., 'Research Report: Retrofit interventions to enable healthy living conditions in existing New Zealand homes'. Report for EECA, prepared by the Energy Studies Group of Otago University, July 2009.

Ministry for the Environment. (MfE) *SWAP – Solid Waste Analysis Protocol*. (www.mfe.govt.nz/laws/ris/ris-landfill-gas.html accessed June 2010).

Ministry for the Environment. (MfE, 2010) *The New Zealand Waste Strategy'*. (www.mfe.govt.nz/publications/waste/waste-strategy/)

Ministry for the Environment. *Food Waste (*www.sustainability.govt.nz/rubbish/food-waste accessed July 2010).

Ministry for the Environment, *National Environmental Standards for Air Quality*, (www.mfe.govt.nz/laws/standards/air-quality/index.html accessed March 2011).

Ministry for the Environment. *National Environmental Standards for Sources of Human Drinking Water, 2009*. (www.mfe.govt.nz/laws/standards/drinking-water-source-standard.html accessed April 2011).

Ministry for the Environment *Statement of Intent, 2010-2013.* (www.mfe.govt.nz/publications/about/soi/2010/statement-of-intent-2010-2013.pdf accessed December 2010)

Ministry of Economic Development, *New Zealand Energy Strategy to 2050, Powering our Future* http://www.med.govt.nz/upload/52164/nzes.pdf 2008, accessed December 2010).

Ministry of Social development, *Fuel poverty in New Zealand. (*www.msd.govt.nz/about-msd-and-our-work/publications-resources/journals-and-magazines/social-policy-journal/spj27/fuel-poverty-on-new-zealand-27-pages142-155.html) accessed September 2010)

New South Wales Department of Planning, NSW Housing code – 2010, BASIX, (www.housingcode.planning.nsw.gov.au/) accessed December 2010

New South Wales Office of Environment and Heritage. *NaBERS, National Building Efficiency Rating Scheme*, (www.nabers.com.au/ accessed May 2011).

New Zealand Department of Statistics, 1973. 'Report on the Survey of Household Electricity Consumption 1971-72'. New Zealand Department of Statistics, Wellington, New Zealand.

New Zealand Department of Statistics, 1976. 'Survey of Household Electricity Consumption 1971-72 – Report on the Temperature/Insulation Study'. Government Printer, Wellington, New Zealand.

New Zealand Department of Statistics, 2006. *Census 2006.* (www.stats.govt.nz) August 2010.

Page, I., and Burgess, J. 2009. 'Cost benefits of sustainable housing retrofits'. BRANZ report prepared for Beacon Pathway Ltd. BRANZ Ltd, Judgeford, New Zealand, 2009.

Page, I. C., and Fung, J. 2009. 'Housing life cycle and sustainability. Part one'. *BRANZ Study Report no. SR 214*, BRANZ Ltd, Judgeford, 2009.

Page, I. C., 2009. 'Housing life cycle and sustainability: Part two'. *BRANZ Study Report no. SR 235*, BRANZ Ltd, Judgeford, New Zealand.

Phipps, R., 2009. 'Indoor Environment Quality'. Report TE220 for Beacon Pathway Limited. BRANZ Ltd, Judgeford, New Zealand..

Pollard, A., French, L., Heinrich, M., Jaques, R. and Zhao, J. 2009. 'Waitakere NOW Home® Performance Monitoring: Year Two'. Report NO102/4 for Beacon Pathway Limited. BRANZ Ltd, Judgeford, New Zealand.

Queenstown Lakes District Council, *Water Demand Management Plan, 2007*. www.qldc.govt.nz/images/Files/Water_Demand_Management_Plans/Queenstown_Water_Demand_Management_Plan.pdf Accessed December 2010

Raw, Gary J., Aizlewood, Claire E. and Hamilton, Ruth, M. 2007. 'Building Regulation, Health and Safety'. BRE Report BR417, Building Research Establishment, Watford, England.

Ryan, V., Burgess, G., Easton, L., 2008. 'New Zealand Home Typologies to Inform Energy Retrofits'. Report Energy 6570/9, Beacon Pathway Ltd., Auckland, New Zealand.

Smarterhomes. *SmarterHomes.*( www.smarterhomes.org.nz accessed July 2010)

Standards New Zealand, NZS 4218P:1977. *Minimum Thermal Insulation Requirements for Residential Buildings.* SNZ, Wellington New Zealand.

Standards New Zealand, NZS 4218:1996. *Energy Efficiency – Housing and Small Building Envelope.* SNZ, Wellington New Zealand.

Standards New Zealand. NZS 4218:2009. *Thermal Insulation – Housing and Small Buildings*. SNZ, Wellington New Zealand.

Standards New Zealand. NZS 4218:2004. *Energy Efficiency – Small Building Envelope*. SNZ, Wellington New Zealand.

Standards New Zealand. AS/NZS 3823.2:2009 *Performance of Electrical Appliances – Air Conditioners and Heat Pumps. Part 2 (MEPS).* SNZ, Wellington New Zealand.

United States Green Building Council, (USGBC). *LEED for homes,* 2008 http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147 accessed December 2010 and (www.leedforhomes.org/OST/homepage.aspx ) accessed 4 May 2011.

Williamson, Maurice, 'Sustainable Building in New Zealand'. Speech to the New Zealand Sustainable Building Conference, SB10, Wellington, New Zealand. 27 May, 2010. (www.beehive.govt.nz/speech/speech+nz+sustainable+building+conference accessed June 2010)

World Health Organization (WHO), 1987. 'Health Impacts of Low Indoor Temperatures'. Report on a WHO meeting, Copenhagen, Denmark.

World Health Organization (WHO), 2003. 'Heat-waves: Impacts and Responses'. WHO Briefing Note for the Fifty-third Session of the WHO Regional Committee for Europe, Vienna, Austria. 8-11 September 2003.

## 8.1 Acts of Parliament – updated August 2011

*The Building Act* (2004)
(http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html)

*The Local Government Act* (2002)
(http://www.legislation.govt.nz/act/public/2002/0084/latest/DLM170873.html?search=ts_act_Local+Government+Act_resel&p=1&sr=1)

*The Energy Efficiency and Conservation Act* (2000)
(http://www.legislation.govt.nz/act/public/2000/0014/latest/DLM54948.html?search=ts_act_Energy+Efficiency_resel&p=1&sr=1)

*The Health Act* (1956)
(http://www.legislation.govt.nz/act/public/1956/0065/latest/DLM305840.html?search=ts_act_Health+Act_resel&p=1&sr=1)

*The Resource Management Act* (1991)
(http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html?search=ts_act_Resource+Management+Act_resel&p=1&sr=1)

*The Waste Minimisation Act* (2008)
(http://www.legislation.govt.nz/act/public/2008/0089/latest/DLM999802.html?search=ts_act_Waste+Minimisation+Act_resel&p=1&sr=1)